Newport Research Facility

ANNUAL REPORT

NO. 63

Report for the year ended 31st December 2018

This report follows in sequence from the Annual Reports of the Salmon Research Agency of Ireland Inc. and the Salmon Research Trust of Ireland Inc.

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Summary

1. The Salmon Research Agency of Ireland merged with the Marine Institute on the 1st July 1999 into Aquaculture & Catchment Management Services and in 2010 the group merged with Fisheries Ecosystem Advisory Services. This report provides a continuation of the data records for the Burrishoole facilities.

2. The total rainfall recorded in Furnace in 2018 was 1559.2 mm. Rainfall in 2018 was below average, but not unusually so. Of note low amount of rain from March through to the end of July. The rainfall in May to early July was particularly low, with just one main rain event in mid-June. Months of relatively high rainfall were January, August, September October, November and December.

3. The environmental programme was maintained in the catchment with the network of rain gauges, water level recorders and river and lake monitoring stations all in operation. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites. In the last two decades, the physical, chemical and meteorological data have been supplemented with biological datasets describing zooplankton and phytoplankton assemblages in Lough Feeagh and Lough Furnace, along with macroinvertebrate species occurrence and abundance from 16 index sites. Of note in 2018, Lough Feeagh stratified later, and destratified earlier than in previous years, but with exception of a short period in June, water column stability was exceptionally high in late May/early June and in July.

4. The total release of microtagged smolts of ranched Burrishoole grilse origin was 33,629 comprising of 6 tag codes. Due to the cold spring, groups were released later; on 10th May 2018, three tag groups (15,241) were released into Lough Furnace (morning release) and three groups (18,388) on 11th May (evening release). Conditions at release were cool and breezy on both days.

5. In 2007, the Irish Government introduced a cessation of drift netting for salmon at sea and this was continued in 2017.

6. A total of 317 wild grilse and one previously spawned grilse (psg) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded was 19. The total run of wild grilse, including the Furnace rod catch (0), was 317 + 1 previously spawned grilse as determined by floy tag returns.

7. No escaped farm fish were recorded in the upstream traps in 2018.

8. No pink salmon were recorded in 2018.

9. Returning adults were checked for net mark damage; 0.01% (n=262) of wild salmon (mainly in August) and 2.7% (n=1185) of reared salmon (in June and August) had net marks present.

10. The maximum spawning escapement was estimated to be 340 wild and 51 reared fish.

11. A total of 6475 wild salmon smolts were recorded in the downstream trap in 2018. The wild return of 2017 smolts as wild grilse in 2018 was 6.5%, another slight drop from the 7.4% in 2017. The ova to smolt survival at 0.89 - 0.78%.

12. Wild kelt survival was 37.2% and the tagged kelt return in 2018 as previously spawned grilse later in the year was 0.6%.

13. The percentage return for reared grilse was 5.6%.

14. A total of 21 wild sea trout and a further 64 non-silvered trout migrated upstream through the traps in 2018. Of the silvered trout, 2 were adults and 19 (p0%) were finnock.

15. The 2018 sea trout smolt run amounted to 362 smolts.

16. The percentage of trout smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1989 it collapsed to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's between 4 & 10%, rising to 16.7% in 1999. Finnock return in 2018 was 5.3%.

17. Silver eel trapping continued with the total run amounting to 1997 eels. In 2018, the timing of the run was 15% migrating in August, 42% in September and 30% in October (Table 7.1). Almost 90% of the run was completed by the end of October.

18. A total of 51 salmon were caught in the Rod Fishery in 2018. The catch consisted of 17 wild fish and 34 reared salmon. No wild fish were killed. A total of 6 sea trout were caught on Lough Furnace. Regulations remained in place whereby all rod caught sea trout were returned alive.

19. 2018 marked the completion of 28 years of catchment electrofishing surveys for juvenile salmonids and eel and beach seine surveys of the lakes for juvenile salmonids.

20. Eel fyke net surveys of Bunaveela, Feeagh and Furnace were undertaken in 2018.

21. *Anguillicola crassus*, the non-native swim bladder parasite of eel, was recorded in the saline waters of Lough Furnace for the first time in 2011 and each year since. Infection intensity increased year on year but fell in 2016. This is the first known introduction of an aquatic invasive species into Burrishoole. In 2016, 28 silver eels were checked and 10 were found to be infected with adult worms (35.7%) at an intensity of 2.0% - this was the first recorded incidence of *A. crassus* from above the traps in freshwater in Burrishoole. In 2018, the prevalence was 66.7 in Feeagh yellow eel, 50.0% in Furnace yellow eel and 67.9% in silver eel and the intensities were the highest recorded to date in freshwater, but dropped slightly in saline water.

22. Staff in Newport were authors on 21 peer-review publications and were involved with eight reports in 2018, including six ICES Working Group reports.

Table of Contents

1 Introduction

This report represents a continuation of the scientific aspects of the Annual Reports published by the Salmon Research Agency of Ireland, now integrated into the Fisheries Ecosystem Advisory Services Group (FEAS) of the Marine Institute. The data presented creates a unique record of fish rearing and wild fish census data for the past 48 years. This data is an essential component in the local, regional and national management of salmon, sea trout and eel and is becoming ever more valuable in the light of increasing pressures on natural stocks, such as exploitation, habitat degradation and global climate change scenarios. The fish monitoring facilities in Newport, along with the reared and ranched salmon stocks held in Burrishoole, are also essential for supporting projects such as development of novel enhancement techniques, alternative stocks and ranching and evaluation of interactions between farmed, ranched and wild strains. An expanding programme in the Burrishoole system is including ecological and genetics research into eel, sticklebacks and stock dynamics of juvenile salmonids and eels.

2 Environmental Data

2.1 Mill Race Data

2.1.1 Rainfall

Daily meteorological data were collected during 2018 at the manual Met Station in Furnace. The monthly rainfall figures for 2015, 2016, 2017 and 2018 are given in Table 2.1, along with the annual totals for the years 1977 to 2018. Rainfall in 2018 was below average, but not unusually so. Of note was the low amount of rain from March through to the end of July. The rainfall in May to early July was particularly low, with just one main rain event in mid-June.

Months of relatively high rainfall were January, August, September October, November and December. Low rainfall was recorded from March through to the end of July. The total rainfall was 1559.2mm. Daily rainfall amounts are shown in Figure 2.1.

Table 2-1: Monthly rainfall totals (mm) for the Furnace Station in 2015, 2016, 2017 and 2018 and the annual totals for 1977 to 2018.

Month	2015	2016	2017	2018	Year	Total	Year	Total
January	257.4	186.2	87.70	262.7	1977	1579.7	2000	1833.2
February	148.9	214.1	157.70	155.0	1978	1592.2	2001	1298.7
March	150.0	139.5	225.80	87.3	1979	1653.3	2002	1715.9
April	123.5	96.5	25.30	86.2	1980	1792.1	2003	1353.2
May	161.1	49.35	63.10	63.7	1981	1646.8	2004	1641.3
June	49.8	102.4	98.80	61.4	1982	1609.6	2005	1608.2
July	152.3	100.7	181.70	55.4	1983	1495.9	2006	1550.7
August	114.0	132	186.25	174.9	1984	1556.6	2007	1576.8
September	155.8	196.1	146.80	142.2	1985	1584.1	2008	1805.0
October	85.3	41.3	169.60	131.2	1986	1886.9	2009	1793.9
November	335.4	160	206.95	150.2	1987	1373.6	2010	1311.6
December	278.4	96.3	181.30	189.1	1988	1715.2	2011	1826.9
					1989	1583.9	2012	1676.4
Total	2011.8	1514.5	1731.0	1559.2	1990	1805.9	2013	1391.8
					1991	1549.6	2014	1723.1
					1992	1771.1	2015	2011.8
					1993	1473.4	2016	1514.5
					1994	1757.1	2017	1731.0
					1995	1382.5	2018	1559.2
					1996	1286.6		
					1997	1351.6		
					1998	1830.9		
					1999	1949.1		

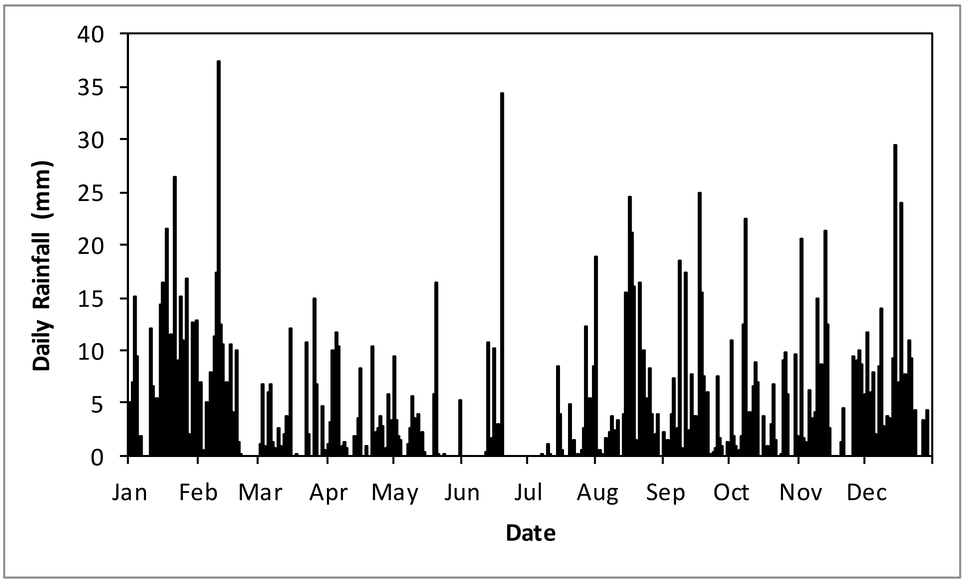

Figure 2-1: Daily rainfall amounts (mm) recorded in the Mill Race manual weather station in 2018.

2.1.2 Water Level and Temperature

Water Level: Difficulties were experienced in 2003 with the automatic water level chart recorder which had been in place since before 1970. An OTT Orphimedes automatic water level recorder was installed in late January 2004 and data from this sensor are presented here. Water levels are recorded every 15 minutes and are presented in Figure 2.2 recorded at 00:00 hrs.

The plot in Figure 2.2 shows a period of relatively low water from March through to the end of July. The year was characterised by particularly low water in June and July and then once it rained at the end of July there was relatively high water for the remainder of the year. Upstream fish migration was impaired in May, June and July.

Water Temperature: In 2004, a TidbiT temperature logger was installed along with the chart recorder and this records water temperature every 30 minutes. In 2009, this was upgraded to an OTT Orpheus mini sensor and logger. The temperature logger data are presented in Figure 2.3, recorded at midnight.

In 2018, water temperatures (recorded at midnight) fell to a minimum of 3.3^{0}C in early March during some snow. Temperature was slow to rise during March and April, delaying the start of the smolt migrations. There was then a fairly steady increase in temperature with a rapid increase through May into June to a peak of 19.5^{0}C on the 8th of June. A cool week and a large rain event cooled the water considerable and then in increased again to a maximum of 21.4^{0}C at the end of June. Temperature then fell gradually from the end of July until the end of the year with a relatively mild autumn and winter.

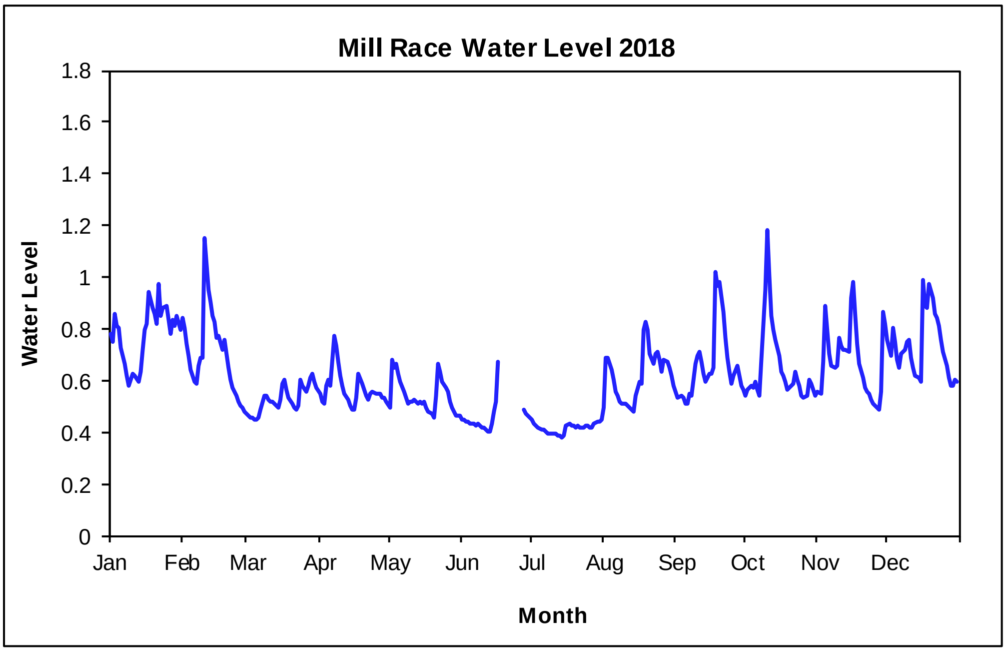

Figure 2-2: Water levels recorded at mid-night for the Mill Race using an OTT Orphimedes automatic water level recorder, 2018.

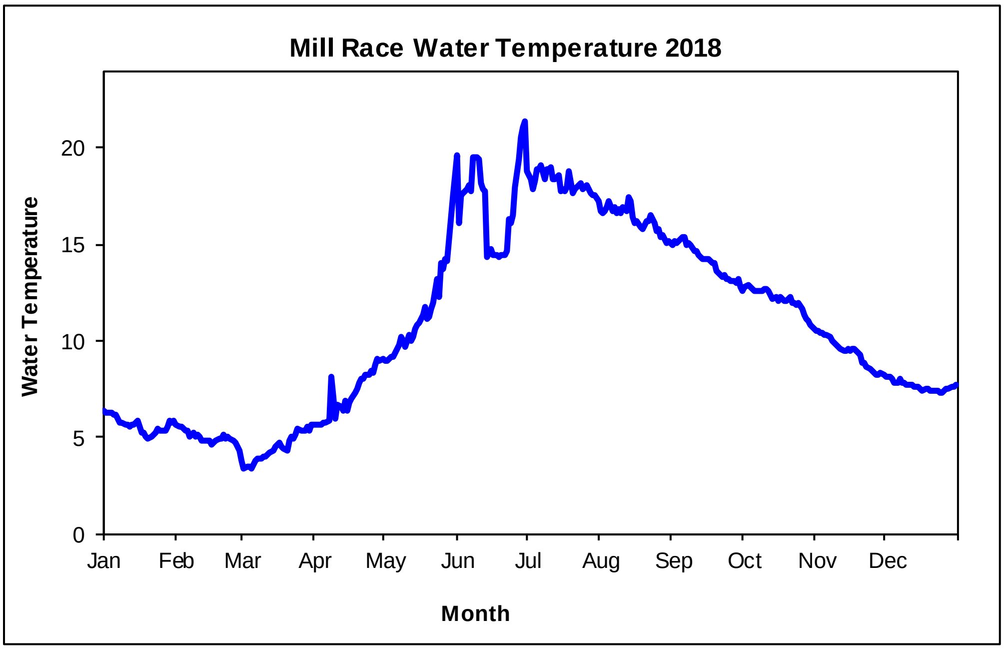

Figure 2-3: Water temperatures (°C) recorded, by OTT Orpheus mini sensor and logger, at mid-night for the Mill Race; some missing data infilled from a TidBit.

2.2 Catchment Programme

2.2.1 Background

Over the last twenty-five years, the Marine Institute has developed a monitoring programme in the Burrishoole catchment, with the aim of ensuring a long term ecological record against which changes in fish biology can be assessed. At the centre of the monitoring program are a series of automatic monitoring stations which measure key aquatic parameters at high frequency. These automatic stations include two lake stations (AWQMS), which have various meteorological instruments included with a suite of underwater temperature and water chemistry sensors, and three river stations, (ARMS), which are equipped with sensors for measuring water temperature, water level, pH, conductivity, dissolved oxygen, and turbidity. The automatic monitoring stations are also equipped with telemetry systems for relaying high-resolution data back to the laboratory. In 2016, we also instrumented the Mill Race with three platinum resistance thermistors (PRTs), a nephelometer (a proxy for turbidity) and a CDOM fluorometer (chromophoric dissolved organic matter). The data from the lake and river stations are complemented by spot samples analysed for water colour, turbidity, Total Phosphorus, Total Nitrogen and ethanol extracted chlorophyll *a*. In addition, the Institute maintains temperature loggers, water level recorders and data-logging rain gauges in the Burrishoole, Owengarve and Owenduff catchments. These instruments allow high-resolution patterns of rainfall to be linked with stream flow. An important feature of the monitoring network is the ability to collect simultaneous data from river, lake, and climatic instruments.

The physical, chemical and meteorological data have been supplemented with biological datasets describing zooplankton and phytoplankton assemblages in Lough Feeagh (since 2003) and Lough Furnace (since 2009), along with macroinvertebrate species occurrence and abundance from 16 index sites (since 2003).

2.2.2 The 2018 Programme

The maintenance and development of long term physical, chemical and biological datasets characterising the freshwater component of the Burrishoole catchment continued in 2018. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites.

2.2.3 The Black River

The main river flowing into Lough Feeagh is the Black River, also known as the Shramore River. A water level recorder is situated approximately 500m above the lake. Figure 2.4 shows the average daily water level for 2018 and Figure 2.5 shows the average monthly water levels from 2002 to 2018.

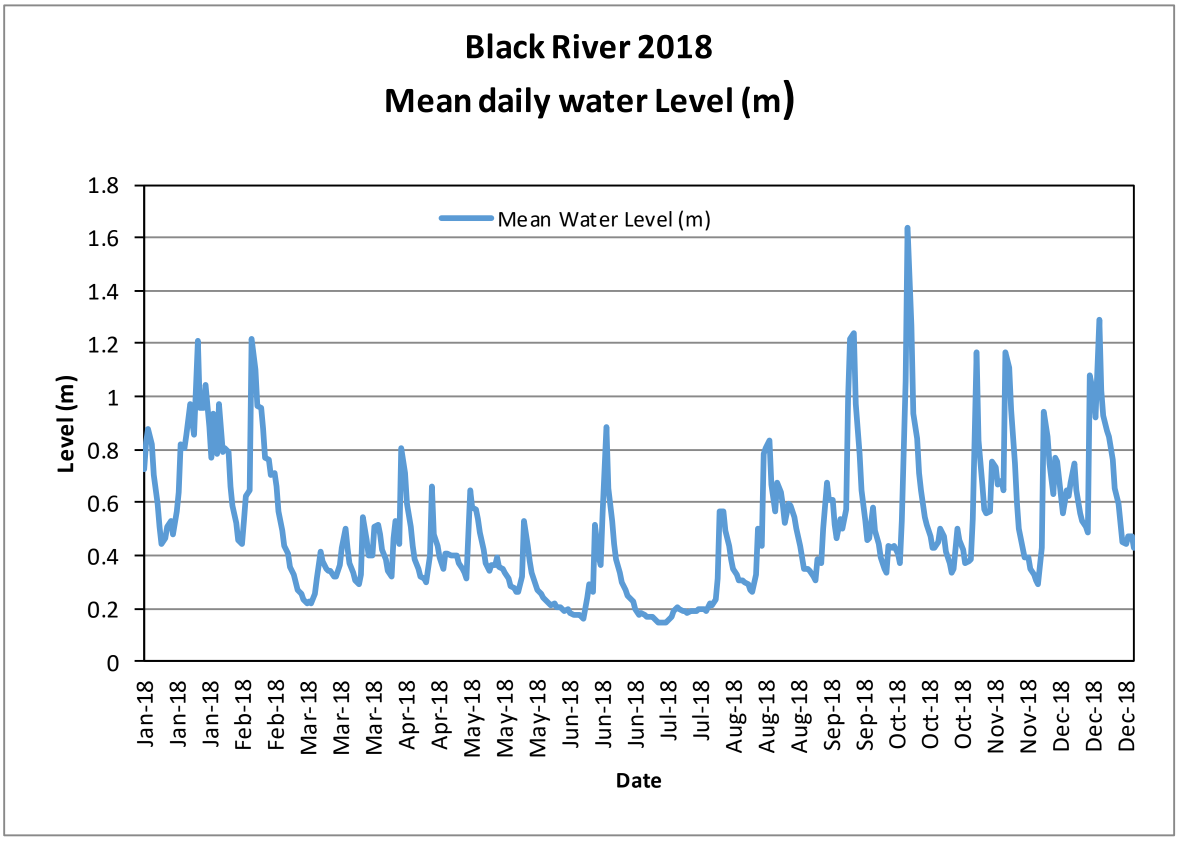

Figure 2-4: Mean daily water level for the Black River, 2018.

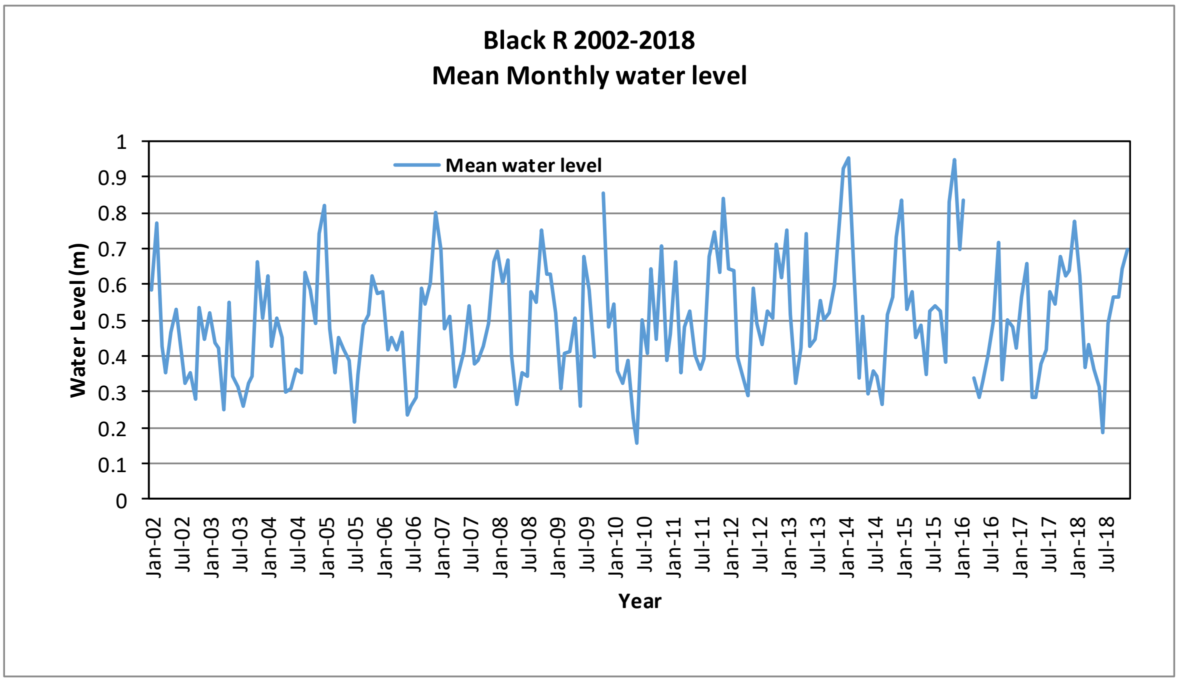

Figure 2-5: Monthly mean water levels for the Black River, 2002-2018.

2.2.4 Lough Feeagh

Lough Feeagh is situated in the Burrishoole catchment in the west of Ireland close to the Atlantic coast and is therefore strongly affected by the temperate oceanic climate that predominates in the region. The water is soft and highly coloured (2017 mean of 89 mgl^{-1} PtCo), and is oligotrophic, with Chlorophyll *a* ranging between 1 and 2$\mu g\ l^{-1}$. Mean annual Total Phosphorous is 6.1 $\mu g\ l^{-1}$ (2017) and Total Nitrogen is 0.43mgl^{-1} (2017). The Lough Feeagh Automatic Water Quality Monitoring System (AWQMS) measures various parameters using a Hydrolab Datasonde 5, two Chelsea Scientific Minitrackas and a Seapoint fluorometer (pH, dissolved oxygen, temperature and conductivity, turbidity, Chl and CDOM fluorescence). There is also a thermistor chain and various weather instruments continually monitoring variables such as barometric pressure, wind speed and wind direction.

The Lough Feeagh AWQMS operated well in 2018. We had some data loss in March 2018, around the time of Storm Emma, when the datasonde got stuck around its chain and broke. We also had some data loss towards the end of the year due to communication faults. The temperature profile indicates a period of stratification between May and October (Fig. 2.6). Maximum summer temperatures reached 22°C. (Fig. 2.7). The onset of stratification was delayed by about two weeks starting in mid-May. The lake then quickly stratified, with the heatwave that was felt across Ireland, before partially destratifying with storm Hector in mid-June. Water column stability was exceptionally high in July as the summer heatwave continued, but the lake subsequently destratified prematurely at the end of September when storm Ali hit on September 18th (Fig. 2.8).

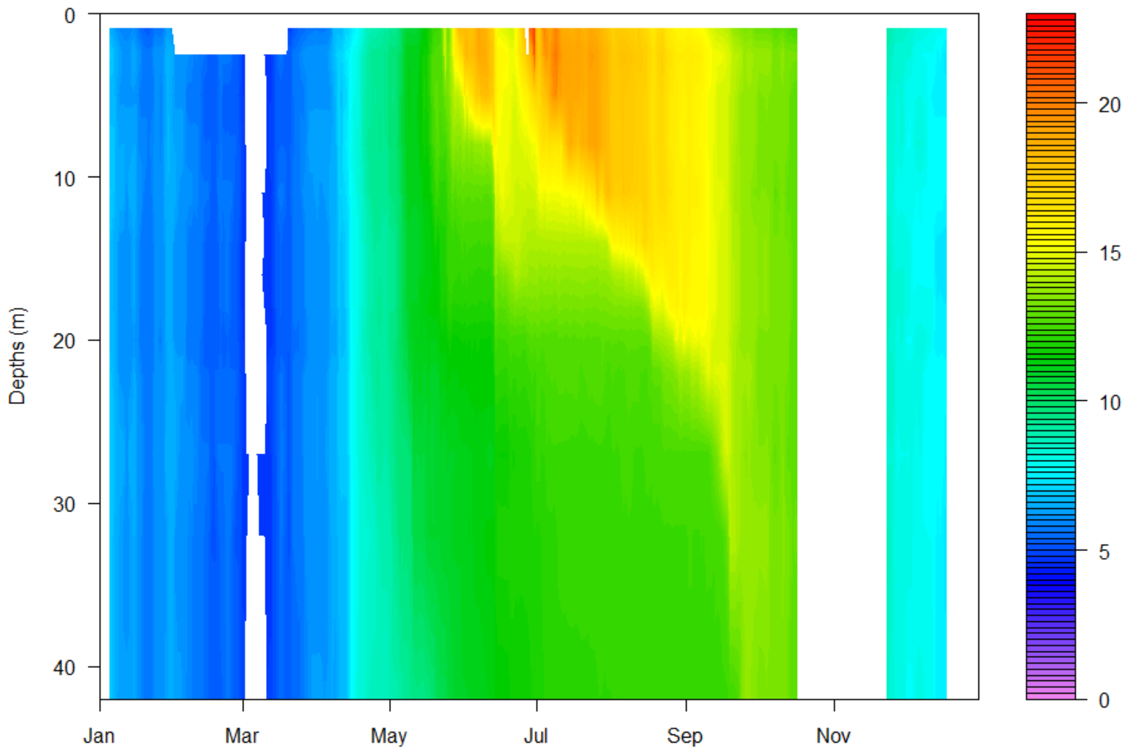

Figure 2-6: Temperature profile for L. Feeagh measured using PRT sensors on the AWQMS for 2018. The white denotes missing data.

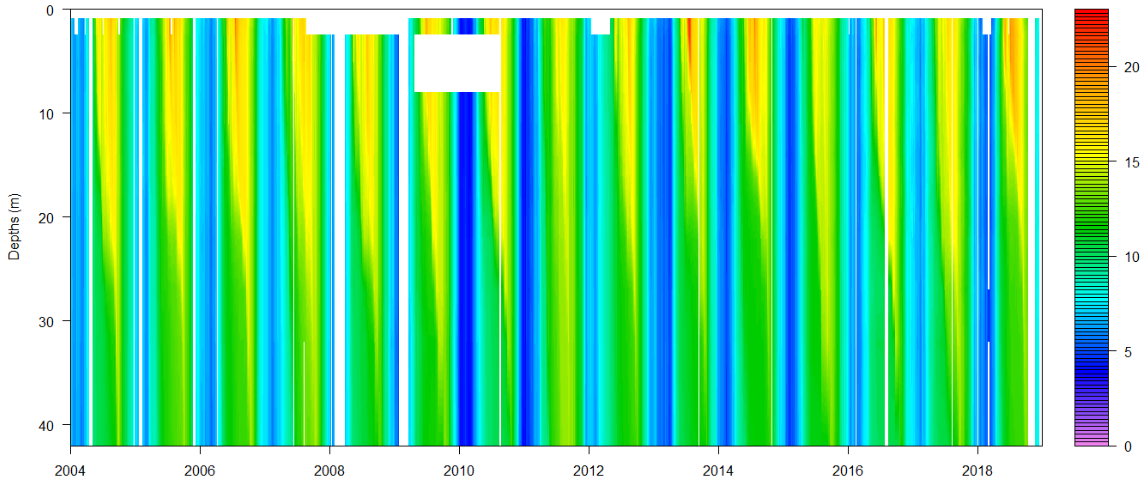

Figure 2-7: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2004-2018. The white areas denote missing data.

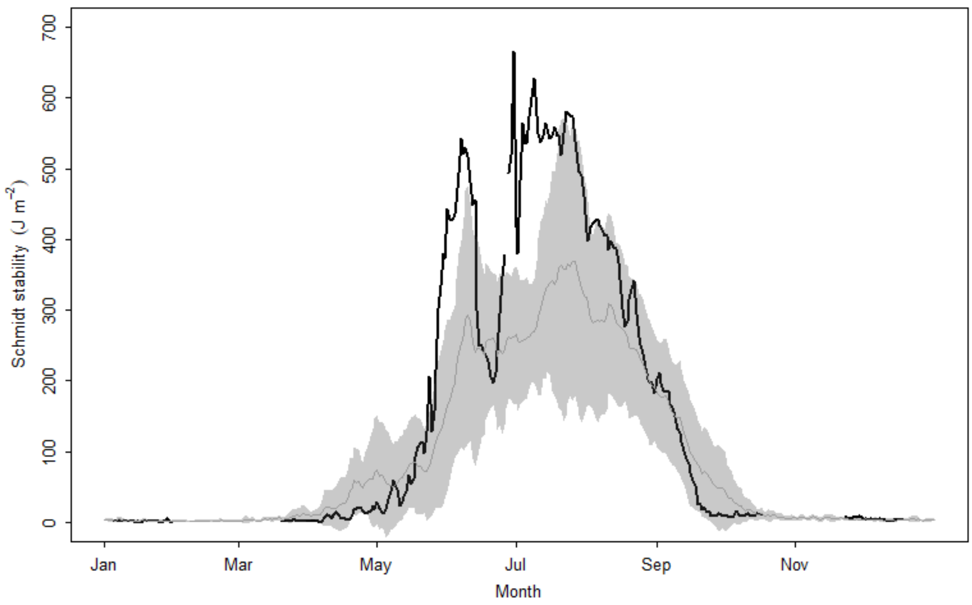

Figure 2-8: Schmidt stability of the water column on Lough Feeagh. The black line indicates the daily measured values for 2018. The grey line indicates the average daily values for the period 2004-2017 ± the standard deviation (shaded grey area).

2.2.5 Lough Furnace

Lough Furnace is situated in the lower end of the Burrishoole catchment. Lough Furnace, (2km from north to south at its widest point, covering an area of 170ha, max depth is 21m with an average depth of 7m) is a cryptodepression tidal lagoon lake. Sea water enters the lake during spring tides but the freshwater exchange ensures relativity low salinities at the surface throughout the year. The lough is thermally stratified throughout the year with spring and autumn inversions and accompanying halo- and oxyclines. Surface Chlorophyll *a* ranged between 0.36 and 6.37μg l^{-1} (Mean annual = 1.74 μg l^{-1}, n=12). Mean annual Total Phosphorous of surface waters was 7.3 μg l^{-1} (2018, n=18) and Total Nitrogen is 0.436mgl^{-1} (2018, n=18). Monitoring of L. Furnace commenced in the early 1970s and automatic daily monitoring commenced in May 2008. This AWQMS (Fig. 2.9) has a Datasonde DX5 attached to a profiling winch, enabling temperature, conductivity, dissolved oxygen (% and mg/l), salinity, chlorophyll fluoresence and pH profiles of the lake to be taken. The winch profiles the lake 4 times a day (6am, noon, 6pm and midnight), taking four hours to run a profile and is parked for two hours. There is also a nephelometer and fluorometer positioned one meter below the water column. All parameters are measured every two minutes. A weather station is also fully functional on the AWQMS measuring wind direction, wind speed, radiation, relative humidity and barometric pressure.

The AWQMS worked relatively well in 2018, until mid-summer, when the winch started having problems. We are therefore missing data for the second half of the year. The water temperature displayed a typical surface cooling over winter, and epilimnetic warming during summer, with a period of near isothermal conditions in June (during storm Hector) (Fig. 2.10). The hypolimnion was hypoxic below 6 metres, for the portion of the year for which we have data (Fig. 2.11), There was some indication of deep water renewal in June 2018, as was recorded in 2010, 2013 and 2014 and 2017. The epilimnion was very shallow in July, with oxygenated water only extending to <3 metres. This was the result of low levels of freshwater flowing down from the catchment, and resulting ingress of tidal, saline waters into the main basin (Fig. 2.12). In mid-July, there was hardly any freshwater at in above the halocline, which is not ideal conditions for salmon returning from the Atlantic. The chlorophyll sensor (reliable between April and July indicated a deep chlorophyll maximum at ~3 meters) (Fig. 2.13).

Figure 2-9: The Automatic Water Quality Monitoring Station (AWQMS) on L. Furnace (left) and the meteorological instruments attached (right).

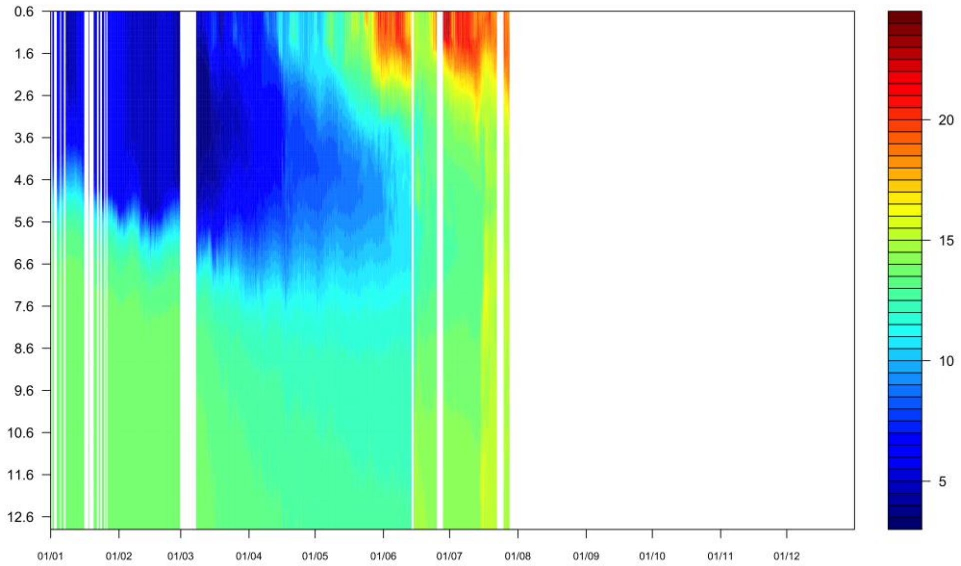

Figure 2-10: Daily average water temperatures (ºC) measured every metre at the deepest point in Lough Furnace in 2018. White indicates missing data.

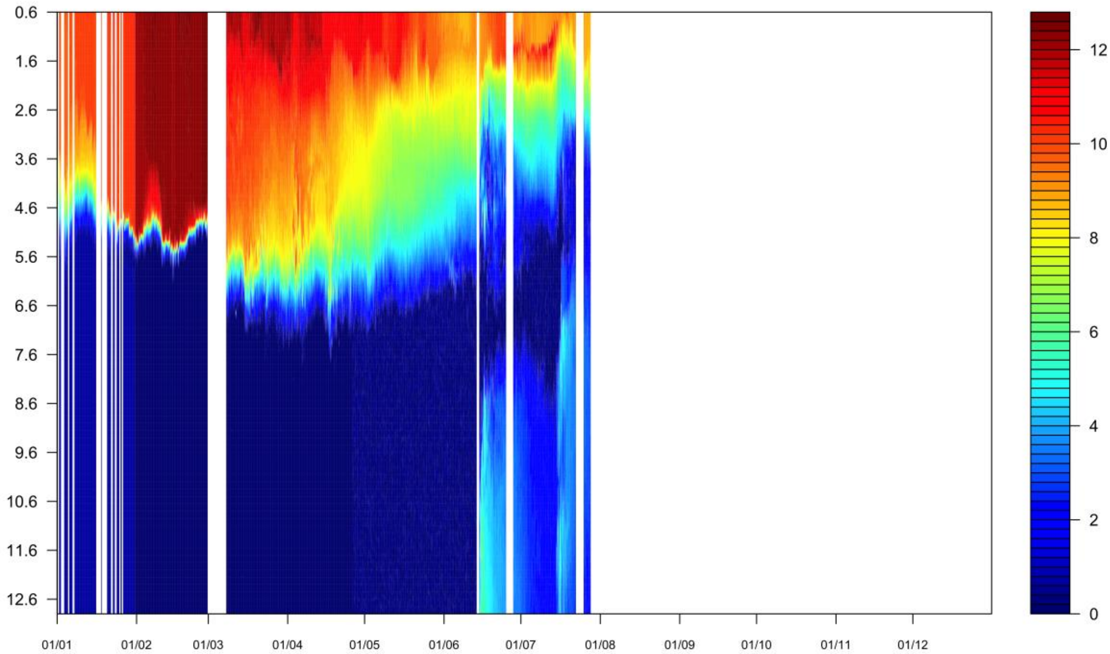

Figure 2-11: Daily average dissolved oxygen (mg/l) measured every metre at the deepest point in Lough Furnace in 2018. White indicates missing data.

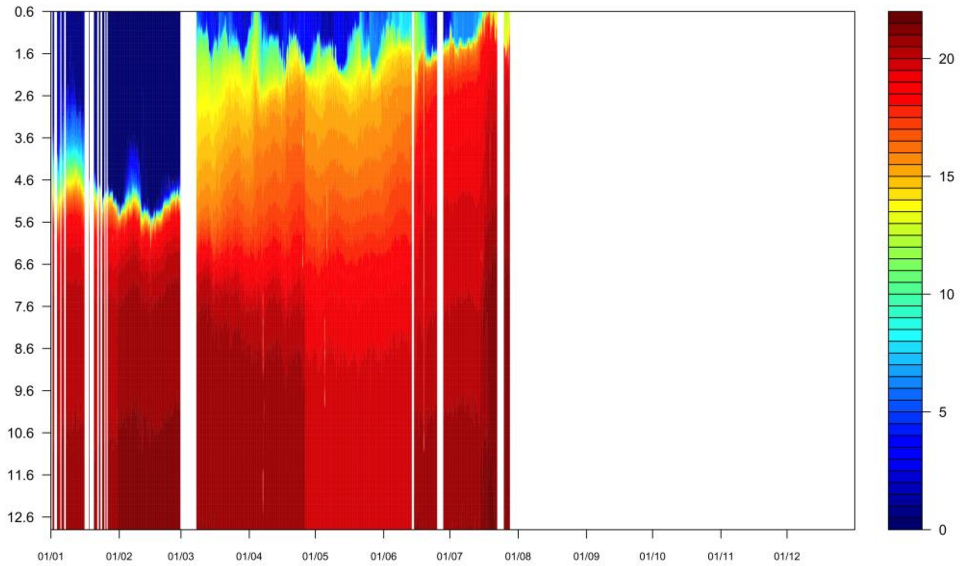

Figure 2-12: Daily average salinity (ppt) measured every metre at the deepest point in Lough Furnace in 2018. White indicates missing data.

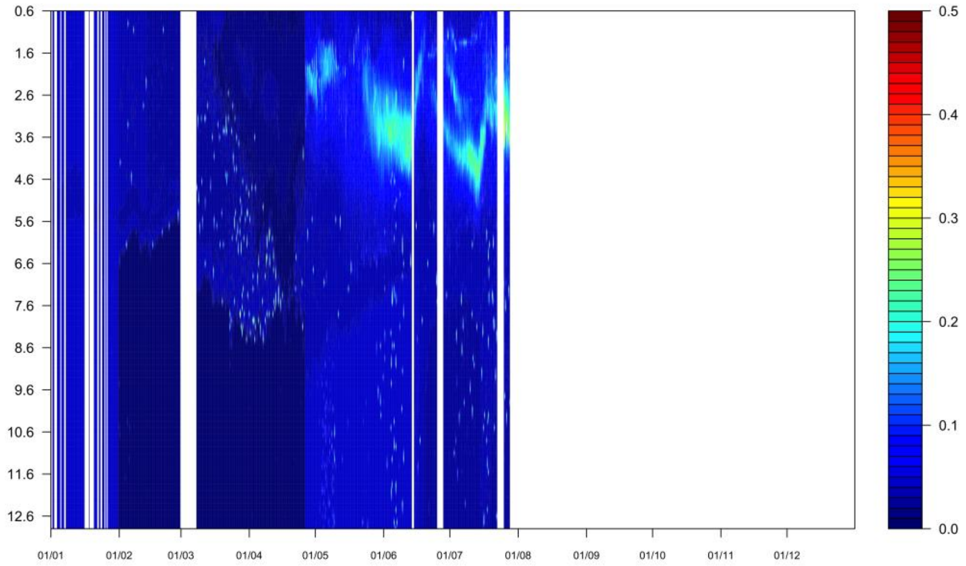

Figure 2-13: Daily average chlorophyll fluorescence (RFU) measured every metre at the deepest point in Lough Furnace in 2018. White indicates missing data.

3 Salmonid Rearing

3.1 Salmon Stocks 2017

3.1.1 Ranching

The total release in 2018 of microtagged smolts of ranched Burrishoole grilse origin was 33,629 comprising 6 tag codes. Following a cold spring, fish were released later than normal: three tag groups (15241) were released into Lough Furnace on 10th May (morning release) and three groups (18,388) on 11th May (evening release). Mean weights of smolt groups released into L. Furnace ranged from 62 to 80 gms. Conditions at release were cool and breezy on both days.

Tag code details are shown in Table 5.1.

3.1.2 Acoustic Smolt Tracking

As part of a Ph.D. study (MI & GMIT collaboration) investigating early migration mortality in salmon from the Burrishoole National Index River, 26 ranch and 24 wild salmon smolts were acoustically tagged during May 2018. In addition, 20 hatchery reared salmon smolts of farmed origin (10) and wild Burrishoole origin (10) were acoustically tagged as part of the Science Foundation Ireland project. Smolts were tracked through Furnace and into Clew Bay as far as Clare Island, using an array of receivers.

3.2 Salmon Stocks 2018

An estimated 62,000 Burrishoole ranch eyed ova from six stripping dates were retained for ongrowing. Water temperatures ranged from 8.0^{o} C at the commencement of first feeding in late April to 12.0^{o} C on 22nd May when the last group commenced first feeding. Growth and survival were good with an overall survival of 89% from first feeding to grading in September. Ranch salmon were mixed in November 2018 to produce core medium and large grade release groups. Stock remaining in December 2018 was 39,298: 27,885 salmon were retained for the ranching programme and the remaining surplus (11,413) were retained for ongrowing and transfer as smolts to the MI sea site.

3.3 Salmon Stocks 2019 (Grilse ova laid down in 2018/'19)

An estimated 57.4% of all returns (1060/1846), 57.1% (1043/1826) of ranch grilse returns and 85% (17/20) of 2SW returns were processed between May and August.

Broodstock collection commenced on 2nd August 2018 and salmon were held in ponds until transfer to the broodstock holding pond on 28th August (41 males, 83 females). Surplus ranch fish collected in August and early September and held in ponds (261) were culled in October. Broodstock collection continued into December and in total 544 ranch adults (533 examined to determine sex: 296 females, 237 males) were held during the stripping period (November 2018 – January 2019). A total 140 females and 149 males were stripped (total 289). On 27th November 116 females were culled as there was a large surplus of female broodstock. Remaining surplus fish (139) were culled on 21st January 2019.

In December, average water temperature was 7.4^{0}C, ranging 7.0^{0}C to 7.8^{0}C. Salmon were examined over a six-week period (28th November to January 14th 2019), to recover ripe females for egg production.

An estimated 403,000 green ova were produced by 137 females. The average fecundity value was 3,035 ova per grilse female (n=129). A proportion of each family, from confirmed Burrishoole stock, was retained in the hatchery from each of the five stripping dates, totalling 49,600 eyed ova from 120 females and 129 males. Ova quality and survival was good. Broodstock condition was good throughout the holding period. Thirty ranch salmon broodstock were sampled in January 2019 and subsequently certified by the Marine Institute Fish Health Unit as disease free.

3.4 Experimental Salmon Stocks 2017

The Institute are collaborators with UCC in a research programme funded by Science Foundation Ireland (SFI), 'Wild farmed interactions in a changing world: formulation of a predictive methodology to inform environmental best practice to secure long-term sustainability of global wild and farm fish populations'. The overall purpose of the work packages is to support studies designed to understand the genetic mechanisms (genetic architecture) underpinning the expression of critical life history traits in the wild associated with the fitness of the progeny of wild and farm salmon and the progeny of resident and anadromous brown trout. Experimental populations were produced in 2016/17 for a work package examining the relative performance of the juvenile progeny of Atlantic salmon from farm and wild genetic backgrounds, undertaken in the experimental controlled section of the Shrahevagh River and also under hatchery conditions. Following the production of experimental groups (as detailed in Annual Report 2016/2017), an estimated 18,000 fry were retained in the hatchery for ongrowing to the smolt stage and to measure trait responses. Fish were sampled periodically to collect tissues for gene transcriptomic, microbiome and micro-parasitic analyses. In May 2018 the remaining fish from this cohort (2,222 fish) were transferred to the MI marine site at Lehenagh Pool in Connemara.

3.5 Experimental Salmon Stocks 2018

A second experimental population was established in the 2017/18 brood season for the SFI research programme. Wild Burrishoole and farmed salmon of Fanad origin were used to produce pure bred and hybrid families. All broodstock used for egg production were certified disease free by the Marine Institute Fish Health Unit.

An estimated 41,000 unfed fry were released into the Shrarevagh River, above the trap, in May 2018. An estimated 19,600 fry, a subset of representatives from the same families and surplus Fanad stock, were retained in the hatchery for ongrowing to the smolt stage and to facilitate measurement of trait responses in hatchery stock.

In October 2018, approximately 270 fish from each of the four progeny groups (Fanad, Burrishoole wild and reciprocal hybrids) were tagged using passive integrated transponders (PIT) and transferred to three 2.5m tanks for ongrowing to the smolt stage. Using PIT tags, which have a unique identification code, enabled UCC researchers to identify individual fish when measuring growth and trait responses. Remaining fish from each of the three progeny groups were also ongrown with a view to transferring groups to the MI marine site and ranching groups in 2019.

Surplus Fanad and a group of Burrishoole ranch salmon parr were used to produce S1/2 smolts during the autumn and were transferred to the MI sea site at Lehanagh Pool in December 2018. Fanad smolts (n=2,568) averaged 74g and Burrishoole smolts (n=2,268) 58g at transfer.

4 Salmon Census Programme

The salmon census and stock assessment programme was continued in 2018 with a full upstream and downstream census of migrating wild salmon. The data provides a valuable index of salmon survivals (freshwater and marine) and stock dynamics for the freshwater components of the stock.

4.1 Wild Salmon and Grilse

4.1.1 Wild Salmon & Grilse

A total of **317** wild grilse, and **1** previously spawned grilse (from floy tag returns), were recorded moving upstream through the permanent traps during the season (Table 4.1 and 4.2).

Water levels were low at the end of May and beginning of June, some showery weather during mid-June led to a slight rise in water levels. However, water levels began to drop towards the end of June and continued to drop during July. As a result of the low water conditions only 18.2% of the total upstream migration was recorded by the end of July. Water levels began to rise during the first week of August and 76.3% of the migration occurred during this month compared to 12.9% for the same period last year, 2017.

Due to the low water conditions and increased water temperature in June it was decided to net the Mill Race pool on July 2nd to divert fish into the upstream trap. In all a total of 20 wild salmon (all recorded and released upstream) and 127 ranched fish were recorded in the upstream trap.

The total number of spring fish recorded for the year in the upstream traps was **19**.

The total wild grilse return to fresh water was **317** and **1** previously spawned grilse.

4.1.2 Farm Escapees

There were no farm escapes recorded in 2018.

4.1.3 Pink Salmon

There were no Pink Salmon (*Oncorhynchus gorbuscha*) recorded in 2018.

Table 4-1: Monthly wild grilse totals for the Salmon Leap and Mill Race traps, 2018.

	Mill Race	Salmon Leap	Total	%
May	0	1	1	0.3
June	9	31	40	12.6
July	16	1	17	5.4
August	0	242	242	76.3
September	3	7	10	3.2
October	0	2	2	0.6
November	3	0	3	0.9
December	2	0	2	0.6
	33	284	317	100

Table 4-2: Monthly proportions (%) of the wild grilse run timing 2007-2018.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
May	0.3	0.0	0.0	0.0	0.2	0.1	0.7	0.4	0.0	0.9	0.6	0.3
June	7.7	9.1	4.6	0.9	16.8	29.8	13.2	11.8	1.9	37.7	40.8	12.6
July	56.3	17.9	78.7	75.8	43.4	57.1	45.0	61.6	86.6	29.1	43.7	5.4
August	17.5	62.6	15.5	15.5	29.8	10.1	26.6	19.2	6.1	9.2	12.7	76.3
September	14.9	7.3	0.9	6.7	8.4	2.4	10.3	0.7	2.5	6.6	0.6	3.2
October	1.0	2.9	0.2	1.0	0.6	0.4	2.6	4.8	0.8	12.5	0.9	0.6
November	1.3	0.2	0.2	0.1	0.8	0.0	1.6	1.1	2.0	3.8	0.8	0.9
December	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.2	0.0	0.6

Table 4-3: Wild salmon, grilse and previously spawned grilse (PSGs identified from floy tag recoveries) totals in the upstream traps, 1970-2018; 5 year means and annual data from 2000. * years where the grilse count was raised to account for loss in the traps.

Year	Total Salmon	Total Grilse	Previously Spawned Grilse
1970-'74	14	1145	
1975-'79	36	703	
1980-'84	35	449	
1985-'89	22	492	
1990-'94	16	421	
1995-'99	12	509	
2000-'04	12	542	
2005-'09	22	642	16
2010-'14	27	572	11
2000	6	568	
2001	6	368	
2002	2	648	
2003	18	544	
2004	28	580	
2005	9	532	
2006*	31	530	
2007*	12	1049	
2008	23	548	21
2009	37	549	10
2010	17	686	17
2011	50	523	7
2012	18	671	6
2013	23	710	15
2014	26	271	8
2015	11	635	4
2016	16	530	2
2017	9	529	3
2018	19	317	1

4.2 Net marked fish in upstream traps

In 2007, the Irish Government introduced a cessation on drift netting in Irish coastal waters. The overall incidence of net marks recorded since the cessation in 2007 remains low.

The main upstream migration of salmon was delayed by low water levels in 2018 with the majority of the wild and ranched migration occurring in August and as a result the highest monthly occurrence of net marks was in August.

There was a decrease in the incidence of net marks on both wild and ranched fish during 2018. The wild fish decreased from 1.9% in 2017 to 0.008% in 2019. The incidence of net marks on ranched fish decreased from 4% to 2.7% for the same period.

Table 4-4: Percentage occurrence of net marks on wild and reared salmon, 2018.

	Wild Grilse %	n for wild/month	Reared Grilse %	n for reared/month
May	0	1	0	1
June	0.0	39	1.7	58
July	0.0	1	0.0	0
August	0.9	211	3.1	1011
September	0.0	7	0.0	105
October	0.0	3	0.0	8
November	0.0	0	0.0	2
December	0.0	0	0.0	0
Total	0.01	262	2.70	1185

4.3 Wild Spawning Stock

The spawning stock (escapement) represents the number of fish available for spawning. It is calculated by subtracting rod caught fish and downstream-displaced fish as well as losses due to poaching, disease and predation, which have been estimated at 5% for wild fish and 10% for reared fish not displaced downstream.

In both 2006 & 2007, an additional number of fish, reared and wild, escaped upstream undetected (see previous reports). It is likely that the wild grilse count for those years were minimum figures and this was taken into account for all calculations based on the 2006 & 2007 spawning escapements.

In 2018, it was noted that more reared grilse were recorded in the downstream traps in the autumn than in the upstream traps in the summer. Many of these fish in the DS traps had no floy tag or tag scar. It is likely that these fish ascended around the Mill Race fish fence in high floods in September and, most likely, in October. It is unlikely that many wild fish ran undetected as their behaviour is different to that of the ranched fish. The reared fish tend to hangout in the Mill Race pool below the fish fence as part of their homing behaviour. The reared fish figures have been amended to account for this. It is intended in 2019 to install a new fish fence along the walkways of the Mill Race pool to try to minimise this problem.

4.3.1 Spawning escapement and stock

The total spawning stock in 2018 consisted of 289 wild fish and 51 reared fish (Table 4.5). The reared component was derived from 143 reared fish tagged and released upstream and an additional estimate of 77 fish to account for an unintentional escapement around the Mill Race fish fence and 10 reared grilse release into the Shrarevagh River for a tracking study.

Table 4.6 gives the annual total spawning escapement, the wild escapement and the reared fish component. The spawning escapement of wild fish in 2007 was the highest observed over the last two decades. Particularly poor wild escapement was recorded in the 1990s, in 2001, 2014 and 2018.

4.3.2 Wild salmon broodstock stripped December 2018

No wild fish were taken for broodstock from the catchment in 2018.

Ten adult ranched fish were released with radio transmitters for a spawning behavior study in the Shrarevagh River, above the fish trap. Some or all of these may have spawned naturally.

Table 4-5: Spawning stock of salmon and grilse, 2018.

	Wild grilse (1SW) & previously spawned grilse	Wild Salmon (2SW)	Ranched fish released upstream
Counted in trap	318	19	=143 + 77*
Rod Feeagh	0	0	0
Culled	0	0	0
Broodstock UT	0	0	0
Broodstock DT	0	0	179
Broodstock Upper Catchment	0	0	0
Estimated morts.	14	1	0
Displacement	33	0	0
Spawning stock	**271**	**18**	**=41+10****

* = the difference between the upstream count and the downstream displacement, plus the additional estimated spawning fish (see **)

** = 15 kelts plus the estimated mortality from spawning (62% average from 2016 and 2017)

Table 4-6: Spawning escapement, 1970-2018.

	Maximum spawning escapement	Wild fish component	Reared fish component
1970-'74	1126	986	140
1975-'79	725	683	42
1980-'84	474	430	44
1985-'89	662	428	232
1990-'94	603	348	254
1995-'99	519	428	95
2000-'04	516	494	21
2005-'09	624	587	38
2010-'14	571	544	27
2007	1038	958	80
2008	512	495	17
2009	517	489	28
2010	652	617	38
2011	548	512	36
2012	668	640	28
2013	702	691	11
2014	284	260	24
2015	601	583	18*
2016	539	492	47
2017	530	478	52
2018	340	289	51

* estimated, see table 4.5.

4.4 Survival from Ova to Grilse

The relevant brood year for the 2018 grilse was 2014 with ova hatched in 2015 and smolt migration in 2017 (Table 4.7).

As in previous years, it has been assumed for the purpose of estimating survival that ranched grilse spawned naturally. Specific data are not currently available on differential survival rates of wild and ranched stocks spawned in the wild. All relevant calculations are based on parameters set out in the Ann. Rep. No. 19, 1974.

Table 4-7: Survivals from ova to smolt and smolt to grilse.

Spawning escapement in 2014	284
No. of females	142 -156
Ova deposition	568,000 -642,763
No. of smolts in traps 2017	5029
No. of smolts released	4918
Survival ova to smolt	0.89 -0.78
No. returning grilse 2018	317
Survival smolt to grilse	6.45
Survival to grilse per grilse female	2.23 -2.03

* two estimates of the % females in the run using 50% and 55

4.5 Ova to Smolt and Smolt to Grilse Survival

The survival of ova to smolt recorded in 2018 was 0.9 from a spawning escapement of 284 adults in 2014 (Table 4.7).

The percentage return of grilse in 2018 from the 2017 smolt output was 6.5%, which was slightly lower than the previous year at 7.4%.

The survival to grilse per grilse female was 2.0 – 2.2 (Tables 4.7- 4.8).

Table 4-8: Percent survivals for ova to smolt and grilse per female grilse spawner; comparative data for 5-year averages from 1970-1989 and values for the individual brood years from 1990 onwards.

Brood year-class	% survival rates ova to smolt	survival rates to grilse per grilse female spawner
1970-'74	0.48 - 0.62	1.4 - 1.7
1975-'79	0.63 - 0.73	1.5 - 1.7
1980-'84	0.61 - 0.69	1.7 - 1.9
1985-'89	0.44 - 0.45	1.4 - 1.5
1990	0.47 - 0.54	1.8 - 2.0
1991	0.47 - 0.53	1.8 - 2.0
1992	0.48 - 0.54	1.3 - 1.5
1993	0.39 - 0.45	1.5 - 1.6
1994	0.36 - 0.41	1.3 - 1.4
1995	0.83 - 0.93	1.9 - 2.1
1996	0.53 - 0.61	1.8 - 1.9
1997	0.52 - 0.59	1.4 - 1.5
1998	0.58 - 0.60	2.4 - 2.6
1999	0.79 - 0.70	1.8 - 2.0
2000	0.56 - 0.64	1.9 - 2.1
2001	1.30 - 1.10	2.9 - 2.6
2002	0.56 - 0.64	1.7 - 1.9
2003	0.68 - 0.76	3.7 - 4.1
2004	0.53 - 0.60	1.8 - 2.0
2005	0.69 - 0.61	2.0 - 2.2
2006	0.75 - 0.67	2.4 - 2.6
2007	0.34 - 0.30	0.9 - 1.0
2008	0.65 - 0.57	2.4 - 2.6
2009	0.75 - 0.66	2.7 - 2.5
2010	0.49 - 0.43	0.8 - 0.9
2011	0.66 - 0.74	2.3 - 2.1
2012	0.53 - 0.47	1.6 - 1.4
2013	0.52 - 0.46	1.5 - 1.4
2014	0.89 - 0.78	2.2 - 2.0

4.6 Salmon Smolts

4.6.1 Wild Salmon Smolts

Although water heights were adequate for downstream migration during April water temperatures were slow to increase. The mean air temperatures in Newport (Met Eireann) were lower in the first 3 months of 2018 than in the previous 3 years.

Therefore, the salmon smolt run in 2018, was different from recent years in that the weather was colder than normal during the smolt period and fish ran generally at night and in relatively small numbers. There were few days with bright sunshine and as a result the afternoon count in the traps was generally low.

There was no major peak in migration but rather a series of pulses of between 200 and 400 fish (Fig. 4.1).

The low daily numbers of fish migrating during 2018 was advantageous as it reduced the potential stress as all smolts were scanned for pit tags.

Additional sampling of smolts was carried out during 2018 in support of two ongoing Cullen fellowship projects examining salmonid migration.

The number of smolts counted decreased from 7362 in 2016 to 5029 in 2017 but showed an increase in 2018 to 6475 (see Fig. 4.1)

4.6.2 PIT Tag Recaptures

230 wild salmon smolts with PIT tags were recorded in the downstream traps between January and August, of which 224 were released downstream. These fish were previously tagged as parr in the catchment as part of a Cullen Fellowship project.

No wild salmon parr with PITs were recorded in the rest of the year.

4.6.3 Ranched Salmon Smolts

There were no ranch smolts released into the catchment above the traps in 2018.

30 PIT tagged salmon smolts of reared origin, released from the Rough River Trap, were recorded in the main downstream traps, of which 22 were released downstream.

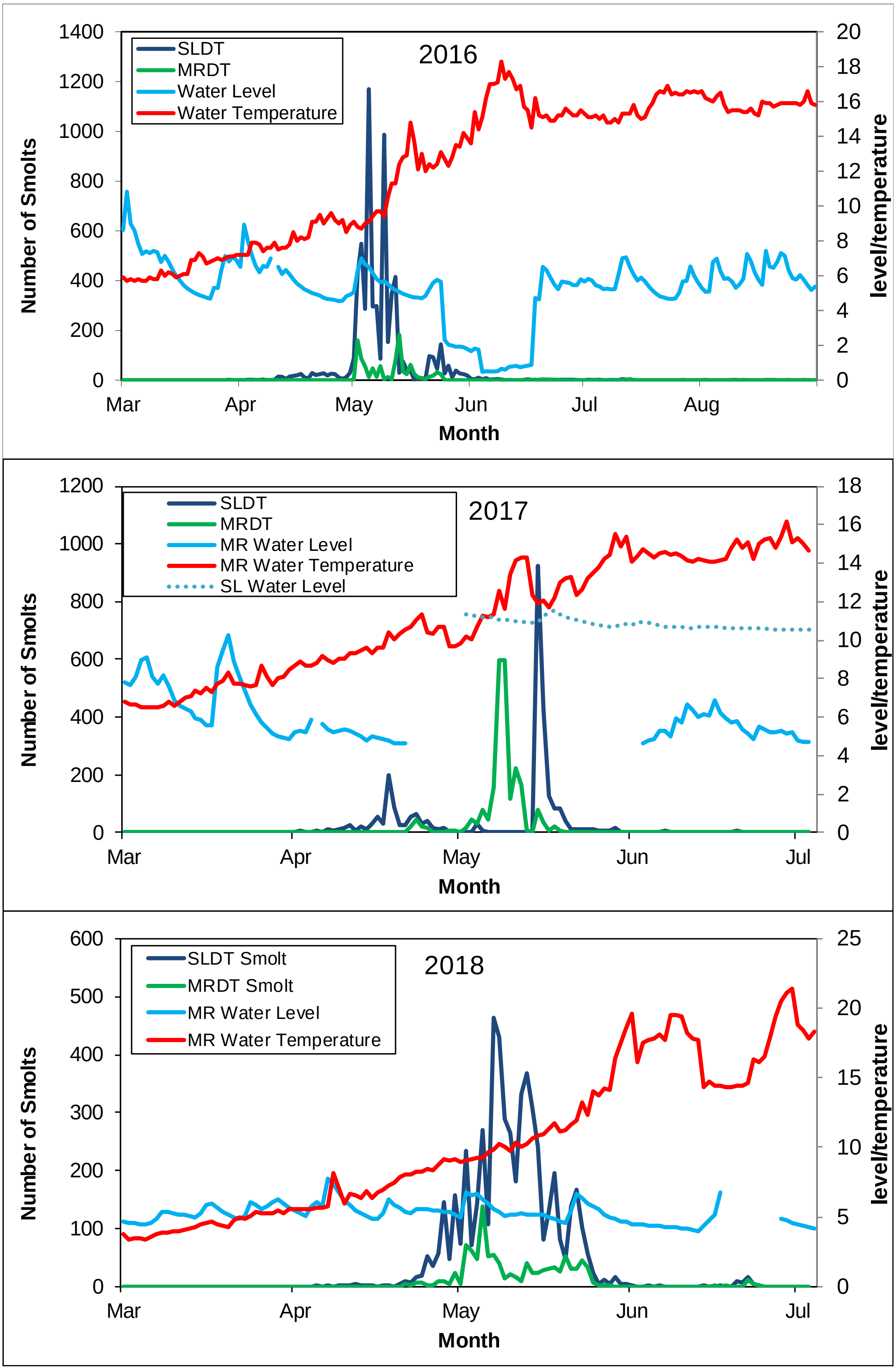

Figure 4-1: Timing of the 2016, 2017 and 2018 wild salmon smolt runs in the Salmon Leap and Mill Race traps with daily midnight MR water level (m x 10) and midnight temperature (⁰C). In 2017, the Salmon Leap water level has been inserted to cover the gap in the MR data. Note the different x-axis scale in 2016.

Table 4-9 : Number of wild salmon smolts counted in 2018.

Month	Salmon Leap Down Trap	Mill Race Down Trap	Total
March	0	0	0
April	564	64	628
May	4840	933	5773
June	45	18	63
July	0	0	0
August	8	0	8
September	2	1	3
TOTAL	**5459**	**1016**	**6475**

Table 4-10: Annual numbers of wild salmon smolts recorded in the downstream traps and the number released after sampling and mortalities have been removed.

Year	1990-'94	1995-'99	2000-'04	2005-'09	2010-'14	2012	2013	2014	2015	2016	2017	2018
Smolts Counted	5618	7052	7490	7351	7195	7717	6357	8150	7034	7362	5029	6475
Smolts Released		6967	7340	7138	6966	7542	5960	7957	6832	7170	4918	6227

4.7 Wild Salmon Kelts

4.7.1 Census

Kelts migrate downstream after spawning. A total of 208 wild salmon kelts were recorded in the downstream traps between December 2017 and May 2018 (Table 4.11).

Survival of wild fish to kelt was 37.2% and over 93% of these were recorded as being in good condition (Table 4.12).

Table 4-11: Numbers of wild salmon kelts counted in 2018.

Month	SLDT	MRDT	Total
December '17	1	1	2
January '18	15	1	16
February	26	5	31
March	85	0	85
April	39	1	40
May	2	0	2
June	2	0	2
	170	8	178

4.7.2 Tagging of wild kelts

Following the cessation of drift netting during 2007 and the corresponding increase in the wild spawning stock at Burrishoole, annual tagging of the wild kelts recommenced during 2008.

A total of 161 floy tagged kelts were released from the downstream traps in spring 2018. 63 of these also had PIT tags inserted.

Subsequently during the summer of 2018, 1 previously spawned grilse, identified by floy tag in the SLUT and pit tag on the Biomark Fixed Antenna, was recovered. The percentage recovery of PSGs decreased from 1.6% in 2017 to 0.6% in 2018 (Table 4.12).

Table 4-12: Comparison of annual salmon kelt runs. A = % healthy kelts in kelt run, B = % males in kelt run, C = % lightly marked, D = % survival from wild spawning escapement, E = % recapture of previously spawned grilse in first year

Year	Kelt Quality Grade				
	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980-84	82	18	6.7	48.7	9.7
1985-89	88	21	5.1	43.2	8.4
1990-94	92	31	4.8	61.4	6.6
1995	74	28	18.3	59.9	2.3
1996	88.1	27	10.1	53.1	4.0
1997	93.7	33.5	6.3	58.9	*
1998	94.3	30.8	5.7	67.6	*
1999	90.6	38.5	4.5	76	*
2000	92.5	44.5	5.5	62.1	*
2001	97	38.5	2.8	72.5	*
2002	91.3	40.9	7.8	49.6	*
2003	95.5	37	3.5	42.3	*
2004	89.9	36.3	9	53.2	*
2005	83.3	35.5	15.3	57.6	*
2006	82.2	36.1	16	54.4	*
2007	95	37.3	4.1	**	*
2008	93.2	26.9	6.8	**	5.6
2009	96.1	20.8	3.3	43.8	4.9
2010	98.1	13.5	1.3	34.2	10.1
2011	95.9	22.7	0.5	35.5	4.1
2012	96.7	20.8	2.8	54.7	3.6
2013	95.1	29.6	4.6	53.9	4.5
2014	91.3	40.7	6.7	51.4	2.4
2015	88.6	27.8	9.8	61.2	2.7
2016	93.8	18.8	6.3	26.6***	1.4
2017	96.1	20	3.4	42.1	1.6
2018	92.9	28.6	7.1	37.2	0.6

* no kelt tagging; ** see section 4.7 (2007 report)

*** Data compromised by Storm Desmond (see 2016 Report)

5 Reared Salmon Census Programme

A programme of rearing and releasing tagged salmon has been carried out in Burrishoole since the early 1960s. The stock was based originally on donor wild salmon from the Burrishoole system and the stock has been closed since using returning tagged fish as broodstock. Additional experimental groups are sometimes released and these are freeze branded and differentially tagged so as to distinguish them from the core ranched stock and avoid including them in the ranched broodstock. The ranched stock facilitates data collection and comparison with the wild stock without putting undue stress or mortality on the wild stock – in this report the components of the ranched stock are known as reared grilse (1SW) and reared 2SW salmon.

5.1 Coastal Returns

Details of coastal returns of Burrishoole fish are available in the Marine Institute 'National Report for Ireland - The 2018 Salmon Season' report.

5.2 Return rate of reared and wild grilse

A total of 2019 nose-cores were recovered from reared fish returning to Burrishoole in 2018 consisting of 12 different microtag codes. Of these fish, 20 were identified as multi sea winter fish and 1856 as one sea winter (grilse) and 143 had no tags.

The overall percentage return for reared grilse returning in 2018 was 5.6% which was significantly higher than the average of 3.6% recorded in 2017. The high survival of ranched fish was not reflected in the survival of wild grilse back to Burrishoole.

The percentage return of wild grilse in 2018 from the 2017 smolt output was 6.5% and was slightly lower than the previous year at 7.4%.

5.3 Recapture of Reared 2SW Fish

The total number of microtagged 2SW reared fish recorded returning to Burrishoole during 2018 was 20, comprising of 6 core release groups. The largest fish was 75.8 cm and 4.9 Kg.

5.4 Smolt Releases 2018

A total of 33,609 ranched smolts were released from Burrishoole during 2018. They consisted of six individual microtag codes, all core groups. All of the groups were released into Lough Furnace, as either a morning (x 3 releases) or evening release (x 3 releases).

For additional information, see section 3.1.1.

Table 5-1: Details of microtag codes and smolt release groups 2018.

Group ID	Tag Code	Mean Wt	Mean Length	No. Released	Date Released
Core	74799	77.1	18.4	6993	11/05/2018
Core	84701	75	18.3	7058	11/05/2018
Core	84709	76.7	18.4	7191	10/05/2018
Core	84708	75.7	18.3	3633	10/05/2018
Core	84720	63.3	17.6	4337	11/05/2018
Core	84721	62.3	17.6	4417	10/05/2018

5.5 Reared kelts

Reared fish often move downstream throughout the late summer and autumn and these are collected for broodstock. A general cut-off date of the 1st December is used to separate these pre-spawned migrants and post-spawned kelts. However, some of the fish migrating downstream in December might not actually have spawned and might end up in the broodstock.

In 2017, 108 were released upstream during the summer. By the end of November 2017 a total of 53 ranched fish were recaptured in the downstream traps and transferred to the broodstock pond. In 2018, an additional 20 fish were recaptured in the downstream traps. Therefore, the total recapture from the 108 released upstream was 73 fish (67.6%).

In 2018, 143 were released upstream during the summer. However, it was noted that the number of ranched fish displaced downstream prior to the spawning season (179) was greater than the number of fish released upstream (143). In 2019, an additional 15 fish were recaptured in the downstream traps (See Chapter 4.3 for additional information).

6 Wild Sea Trout Census Programme

6.1 Upstream Movements: Timing and Numbers.

A total of 21 wild silvered sea trout and a further 64 non-silvered trout migrated upstream through the traps in 2018. Of the silvered trout, 2 were adults and 19 (90%) were finnock. The numbers are compared with other years in Table 6.1. Of the total run of migratory (silvered and unsilvered) trout (85), 75% were unsilvered. For the purposes of this report, the unsilvered trout are not included with the sea trout. Table 6.1 shows that the numbers of sea trout have not recovered in the Burrishoole system and have shown a ten-fold drop since the 1970s.

The timing of the sea trout run in 2018, and in previous years, expressed in monthly percentages, is given in Table 6.2. The highest proportion of sea trout, both finnock and adults, moved upstream in August (76%). The unsilvered trout moved upstream from April through to December, with the highest proportion in August, September and October (59%). A severe drought restricted fish movement in June and July. Many of the unsilvered trout moving in April to June were small fish (parr).

Table 6-1: Annual runs of sea trout recorded in the traps.

Year	Mill Race	Salmon Leap	Total	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	72	206	
1995-99	86	91	177	
2000-04	32	64	97	
2005-09	21	44	65	
2005	5	10	15	
2006	16	22	38	
2007	35	59	94	
2008	4	36	40	
2009	45	93	138	
2010	10	62	72	
2011	15	53	68	
2012	19	120	139	
2013	20	50	70	
2014	16	126	142	
2015	31	28	59	
2016	8	73	81	
2017	1	9	10	
2018	5	16	21	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

Table 6-2: Timing of the Burrishoole (a) silvered sea trout run and (b) unsilvered trout run (in monthly percentages). (n = no. of trout).

(a) Silvered Trout

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04 (483)	2005-'09 (325)	2010-'14 (491)	2015 (59)	2016 (81)	2017 (10)	2018 (21)
May	-	0.2	0.5	0.1	3.1	2.0	1.3	3.2	0.0	6.2	0.0	0.0
June	13.1	24.6	9.4	8.4	8.6	16.7	9.0	6.1	6.3	21.0	20.0	9.5
July	54.4	44.9	62.2	55.0	42.4	37.5	32.5	54.0	75.0	58.0	60.0	4.8
Aug	15.8	10.3	18.4	16.5	19.3	26.4	38.1	22.3	18.8	12.3	10.0	76.2
Sept	7.6	14.8	3.7	8.5	9.8	5.7	13.6	7.8	0.0	1.2	10.0	4.8
Oct	6.4	3.5	4.1	7.9	12.2	10.2	4.7	4.9	0.0	1.2	0.0	4.8
Nov	2.4	1.5	1.5	2.9	4.3	1.5	0.7	1.6	0.0	0.0	0.0	0.0
Dec	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

(b) Unsilvered Trout

	2005-'09 (408)	2010 (104)	2011 (87)	2012 (47)	2013 (101)	2014 (91)	2015 (79)	2016 (95)	2017 (53)	2018 (64)
April	1.4	0.0	3.4	0	1.0	3.3	1.3	0	0.0	4.7
May	7.2	1.0	5.7	0	3.9	9.9	3.8	29.79	0.0	6.3
June	12.4	0.0	3.4	21.7	6.9	12.1	2.5	25.53	11.3	17.2
July	18.3	44.2	12.6	17.4	9.9	30.8	34.2	14.89	37.7	3.1
Aug	20.5	16.3	14.9	13.0	34.7	4.4	20.3	12.77	9.4	26.6
Sept	9.6	17.3	11.5	13.0	9.9	3.3	7.6	9.574	15.1	14.1
Oct	15.7	7.7	11.5	19.6	24.8	25.3	12.7	2.128	11.3	18.8
Nov	10.2	11.5	36.8	6.5	5.0	6.6	13.9	4.255	7.5	4.7
Dec	4.8	1.9	0.0	8.7	5.0	4.4	3.8	1.064	7.5	4.7

6.2 Tag Recaptures in Upstream Migration

In total, 18 trout were detected with PIT tags in 2018. Of these, 6 were identified as brown trout, one as a silvered finnock and 11 were detected on the main antenna in the Denil fish ladder but were not subsequently detected in the upstream trap. The fate of these 11 is unknown due to a problem with the handheld detectors in the upstream trap.

TSU genetics samples were collected from 73 trout, not including seven previously collected for the recaptured fish.

6.3 Spawning Escapement

With the continuation of the catch and release bye-law into the 2017 fishing season, no sea trout were reported killed by anglers on L. Feeagh in 2017. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 85, of which 64 were non-silvered sea trout.

Table 6-3: Annual spawning escapement of sea trout into freshwater, 1970-2018.

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04	2005-'09	2010-'14	2015	2016	2017	2018
Max. Escap.	2090	1146	906	231	289	156	146	184	138	176	63	85
Revised	1622											

6.4 Downstream Movements, Sea Trout Smolts

The 2018 smolt run amounted to 362 smolts, all were released downstream (Table 6.4). Few smolts were recorded from January to March. The main migration occurred in May (75.4%), was delayed by relatively low water temperature in March and April and then and was strongly regulated by both water level and water temperature (Fig. 6.1). The 2018 smolt count was higher than 2017 and similar to 2016, but still low compared to previous years (Table 6.5).

A total of 373 wild trout smolts were measured in 2018. Length measurements were taken to facilitate an estimated age breakdown of the smolt run. The estimated statistics for the 2018 smolts were a mean length of 19.0 cm and a range from 12.3 to 25.6 cm and the length frequency is presented in Figure 6.2 compared with that of 2016 and 2017. This gave an estimated age of 86.6% 2-year-old and 13.4% 3-year-olds.

Table 6-4: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

Month	Salmon Leap	Mill Race	Total	%
January	2	0	2	0.6
February	1	0	1	0.3
March	0	0	0	0.0
April	66	5	71	19.6
May	255	18	273	75.4
June	14	1	15	4.1
July	0	0	0	0.0
Total	338	24	362	
Number Released Downstream			362	

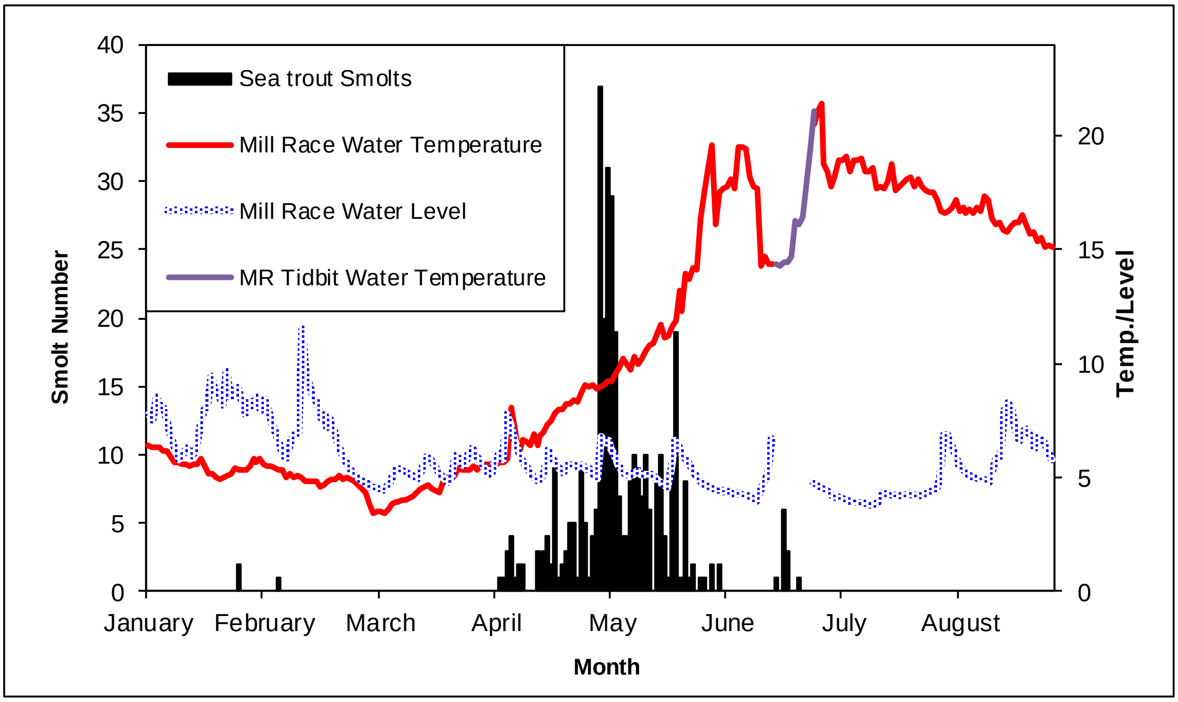

Figure 6-1: Timing of the 2018 wild sea trout smolt migration with daily midnight water level (m x 10) and midnight temperature (⁰C - OTT).

Table 6-5: Annual sea trout smolt numbers in Burrishoole for 1970 to 2018.

	1970-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-'14	‘15	‘16	‘17	‘18
Number of Smolt	4176	4038	4119	1531	1361	816	609	475	426	356	291	362
Number sacrificed				144	35	24	6	10	3	2	0	0

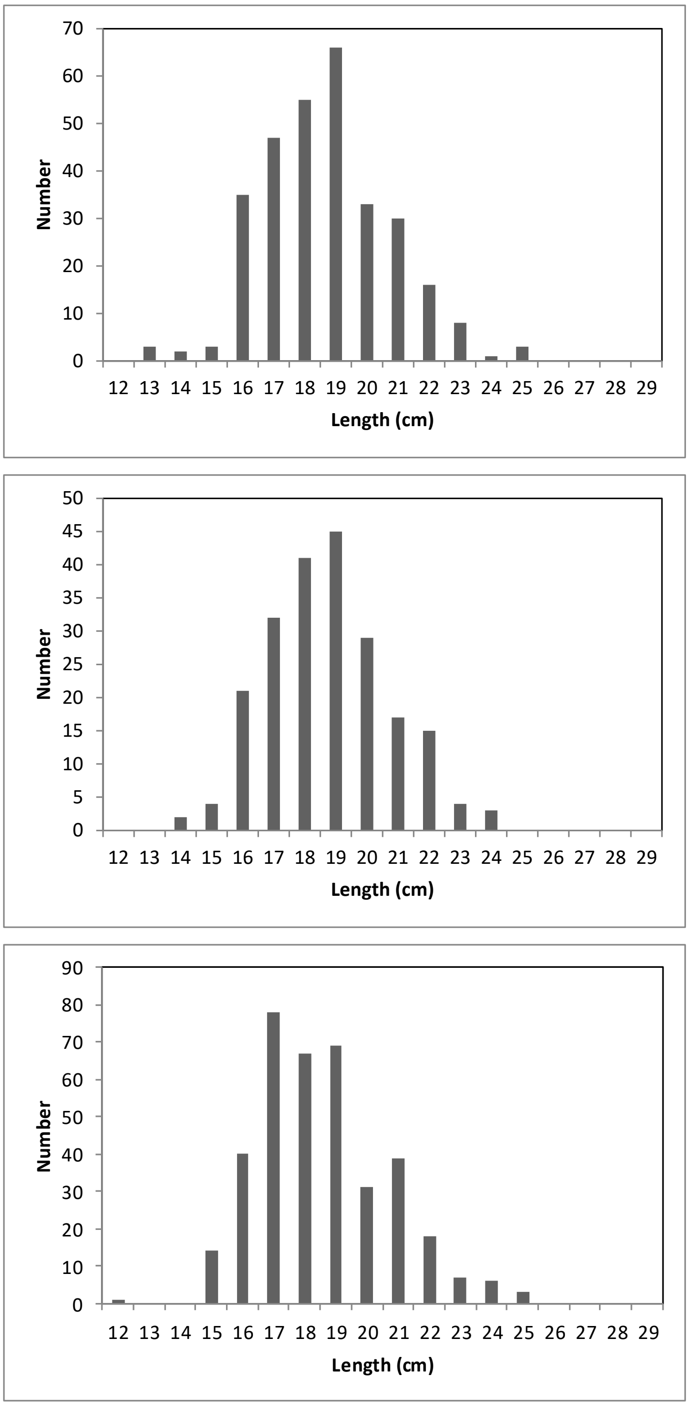

Figure 6-2: Length distributions for smolts in the Burrishoole system, top graph 2016 (n=302), middle graph 2017 (n=213) and bottom graph 2018 (n=373).

6.5 Tagging and Recaptures in Spring Downstream Migration

In 2018, 268 wild sea trout smolts and 3 wild brown trout were PIT tagged in the downstream traps and released. Sixteen sea trout smolts had been previously PIT tagged in the catchment and one tagged finnock was also recorded moving downstream in July.

TSU genetics samples were collected from 375 wild sea trout smolts, 23 wild juvenile brown trout and one sea trout kelt, not including seven previously collected from recaptured fish.

6.6 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock being displaced downstream. It is known through mark-recapture studies that a proportion of the 1+ autumn trout do return the following year as silvered finnock. These runs of trout would appear to becoming more prolonged with substantial numbers of un-silvered 0+ and 1+ trout continuing to migrate downstream in the early months of the year.

A total of 953 juvenile trout entered the downstream traps between July 2018 and May 2019 (Table 6.6). The percentage of 0+ trout that migrated over the period was 31.2% (Table 6.7).

6.7 Tagging and Recaptures in Autumn Downstream Migration

In 2018, autumn trout were not PIT tagged in the downstream traps. Twenty four trout had been previously PIT tagged in the catchment and were recaptured/detected in the downstream traps.

TSU genetics samples were collected in 2018 (up to end of May 2019) from 554 autumn downstream migrants (including some kelts), not including six previously collected from recaptured fish.

Table 6-6: Numbers of migrating autumn juvenile trout in 2018, to the end of May 2019.

Month	0+ Salmon Leap	0+ Mill Race	1+ Salmon Leap	1+ Mill Race	Total Salmon Leap	Total Mill Race
July	0	0	3	0	3	0
August	10	0	35	1	45	1
September	29	2	129	9	158	11
October	77	3	241	0	318	3
November	47	7	78	4	125	11
December	38	0	58	1	96	1
January '19	32	0	27	1	59	1
February '19	8	1	4	0	12	1
March '19	20	1	17	1	37	2
April '19	15	0	25	0	40	0
May '19	7	0	18	4	25	4
Total	283	14	635	21	918	35
Overall Total	297		656		953	

Table 6-7: Percentage of 0+ juvenile trout (<10cm) in the trapped autumn migrating trout.

Year	% 0+	Year	% 0+
1982	50.0	2001	56.3
1983	N/A	2002	32.8
1984	55.8	2003	48.9
1985	30.3	2004	35.5
1986	16.1	2005	37.3
1987	35.3	2006	51.2
1988	60.9	2007	27.9
1989	37.2	2008	28.2
1990	35.2	2009	25.0
1991	26.0	2010	34.9
1992	38.2	2011	37.6
1993	27.6	2012	47.3
1994	16.8	2013	36.1
1995	25.3	2014	36.6
1996	34.0	2015	27.2
1997	18.7	2016	46.4
1998	33.5	2017	37.0
1999	42.0	2018	31.2
2000	47.8		

6.8 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ year olds, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known. It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus the figures for total recruitment up to this time are over-estimated (Table 6.8).

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 6.9). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts. The fate of 1+ unsilvered juveniles migrating down in January to May is unknown but seems unlikely these will contribute to the 2+ spring smolt migration.

Table 6-8: Estimates of total migrant trout recruitment up to 1981.

Year	Smolt Total	Autumn trout (preceding year)	Total Recruitment
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

Table 6-9: Estimates of total migrant trout recruitment from 1982 to date.

Year	Smolt Total	1+ Autumn trout (preceding year)	Total Recruitment
1982-84	3714	1203	4917
1985-89	3706	1063	4778
1990-94	1788	399	2187
1995-99	1361	498	1860
2000-04	816	578	1377
2005-09	610	449	1059
2010	213	267	480
2011	620	501	1121
2012	632	493	1125
2013	485	536	1021
2014	427	351	778
2015	426	481	907
2016	356	334	690
2017	291	365	656
2018	362	436	798

6.9 Marine Survival

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock (0+ sea age) in the same year historically ranged from 11.4% to 32.4% (Fig. 6.3). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's rising to 16.7% in 1999, 18.1% in 2009 and 17.5% in 2010 – the highest return rates since 1986. These increases were not, however, always sustained in subsequent years and there was a collapse in 2005 down to 1.5%. This was associated with the heaviest infestations of sea lice observed in the Burrishoole area since 1992. The return of smolt as finnock in 2011 was 5.8%, 13.8% in 2012, 11.0% in 2013 and 29.5% in 2014 – the highest recorded level since the mid-1970s. The return in 2018 was 5.3%.

The total survival of smolts to their first return to freshwater as finnock in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills *et al*, 1990)) also showed a drop in survival from 1987 to 1989 (Fig. 6.4).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.2% for the 1993 year class of smolts. There was a further increase in 1994 to 17.0% but a drop in 1995 to 8.4%. There were marginal improvements again in 1996 (12.8%) and 1997 (13.1%), a drop to 8.3% in the 1998 year class and a marked improvement in the 1999 year class where marine survival was 20%, the highest recorded in

12 years and back within the pre-collapse historical range. Total survival increased for the 2009 cohort to the highest recorded level since 1988 of 23% and to 23.2% for the 2010 cohort. For the 2011 cohort of smolts, it was 10.2% and for the 2012 cohort it was 17.1%. In 2013 it was 14.4% and rose to 33.0% in 2014 but following the fall in finnock return in 2015 the total return in 2016 fell to half that of the previous year. The total return of 2017 smolts in 2018 was 3.4%.

NOTE: The data used in Chapter 6.6 have been updated in 2014 following a comprehensive data quality control project. None of the changes were significant and the main changes were in 2011 and 2012 following a reclassification of trout considered to be silvered and unsilvered.

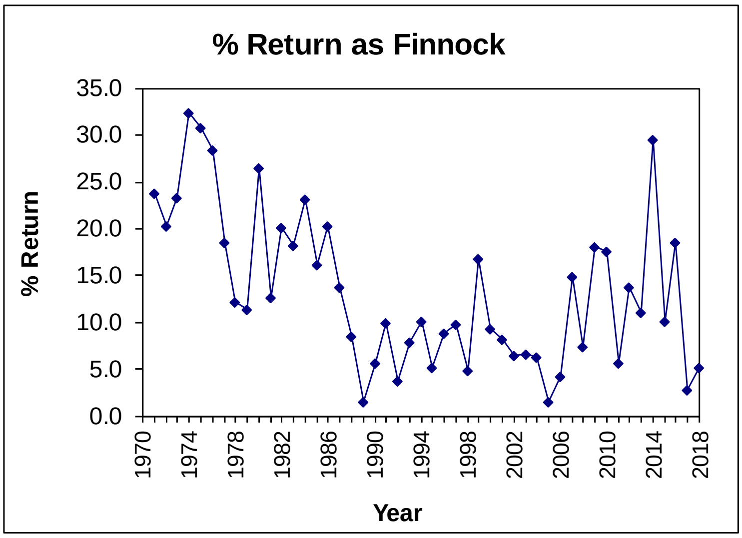

Figure 6-3: Annual percentage return of smolts returning as finnock to the Burrishoole system.

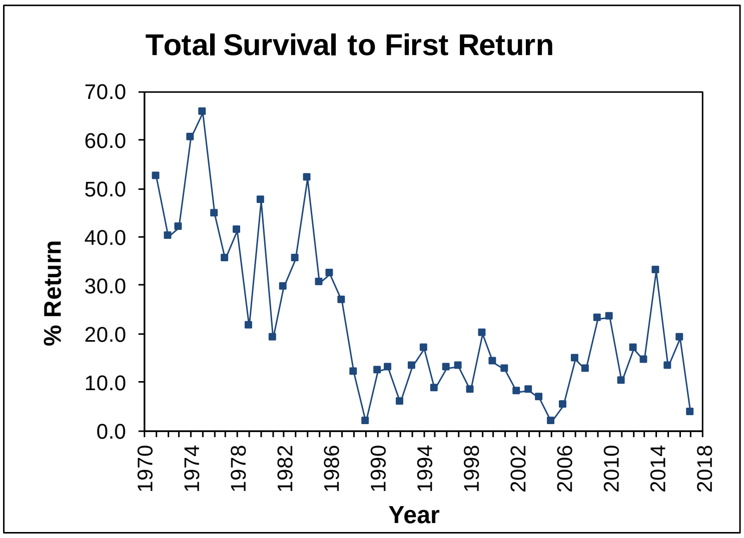

Figure 6-4: Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

6.10 Sea Trout Kelts

Table 6.10 gives the numbers of sea trout and brown trout kelts, both spawned and immature, counted downstream in the winter of 2017 and spring of 2018.

The freshwater survival of kelts is given in Table 6.11. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 6.11. In addition to the size overlap, trout counted upstream as unsilvered migrants may be counted downstream as silvered kelts, and immature autumn downstream migrants may be misidentified as brown trout kelts, both causing additional difficulties in making survival estimates.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may over-winter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

In 2017/18, overall sea trout kelt survival was 30.0% and for finnock only (small sea trout) it was 12.5%. These survivals were relatively low compared to previous years. However, there was a unusually high unsilvered (BT) count downstream so some of these may account for additional sea trout. The total downstream count of sea trout and BT was 93, from an upstream count in 2017 of 63 fish. It is not known what effect the unusual spring and summer conditions of 2017 and 2018 had on smolting, silvering and survival rates.

Table 6-10: Timing and numbers of sea trout kelts for the 2017/2018 season.

Month	Large ST	Small ST	BT	Total ST	Total Trout
October '17	1	0	11	1	12
November	1	0	24	1	25
December	0	0	9	0	9
January '18	0	0	6	0	6
February	0	0	11	0	11
March	0	0	1	0	1
April	0	1	8	1	9
May	0	0	17	0	17
June	0	0	3	0	3
Total	2	1	90	3	93

Table 6-11: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)	Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66	1998	140.10%	" *
1977	63	45	1999	110.40%	" *
1978	50	66	2000	70.10%	"
1979	33	107*	2001	82.00%	" *
1980	50	82	2002	129.60%	" *
1981	44	345*	2003	66.10%	"
1982	53	203*	2004	120.50%	"*
1983	63	177*	2005	142.20%	"*
1984	74	210*	2006	110.50%	"
1985	70	98	2007	228.90%	"**
1986	66	72	2008	98.90%	"**
1987	58.70%	(combined)	2009	107.50%	"*
1988	65.50%	"	2010	59.40%	"
1989	68.70%	"	2011	88.90%	"*
1990	79.00%	" *	2012	117.65%	"*
1991	98.70%	" *	2013	161.33%	"*
1992	89.50%	" *	2014	87.14%	"
1993	96.70%	" *	2015	92.81%	"
1994	104.60%	" *	2016	115.30%	"*
1995	96.20%	“ *	2017	48.20%	"
1996	127.70%	" *	2018	30.00%	"
1997	97.00%	" *			

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

7 Silver Eel Census Programme

7.1 Numbers

The total run amounted to 1997 eels, lower than recorded in 2017. As in other years, the highest proportion of the total catch (84%) was made in the Salmon Leap trap.

There were two large flood events in the silver eel season in 2018.

In 2018, the timing of the run was 15% migrating in August, 42% in September and 30% in October (Table 7.1). Almost 90% of the run was completed by the end of October. Figure 7.1 shows the daily counts of silver eels.

Table 7-1: Timing and numbers of the 2018/'19 silver eel run.

	Salmon Leap	Mill Race	Total	%
May	1	0	1	0.1
June	2	0	2	0.1
July	1	17	18	0.9
August	241	62	303	15.2
September	680	166	846	42.4
October	537	63	600	30.0
November	175	14	189	9.5
December	31	0	31	1.6
Jan. 2019	3	0	3	0.2
February	1		0	0.1
March	2		0	0.1
April	1		0	0.1
Total	1675	322	1997	

7.2 Size

Sampling of individual eels (n = 573) gave an average length of 43.8 cm (range: 30.7 – 96.4cm) and an average weight of 178g (Table 7.2) and the proportion of male eels was 40.8%. The length frequency is presented in Figure 7.2 along with those for 2016 and 2017 for comparison. The lack of eels above 46/47cm was once again notable.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4,400, fell to 2,200 between 1983 and 1989 and increased again to above 3,000 in the '90s (Fig. 7.3). There was an above average count in 1995, possibly contributed to by the exceptionally warm summer. The count in 2001 of 3875 eel was the second highest recorded since 1982. The average weight of the eels in the samples increased from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Fig. 7.3). This has dropped again to an average of of about 177g in the last three years.

In 2012, the majority of the eel run was sampled (n=3317; 99.5%). The run increased from 1969 in 2011 to 3335 in 2012 and the average weight decreased from 180 to 163.5g. The sex ratio changed from 24% to 45% over the past five years. Male eels have remained the same length over the past 15 years (36cm) whereas the females have changed from 53cm (1997-2005) to 50cm (2008-2012).

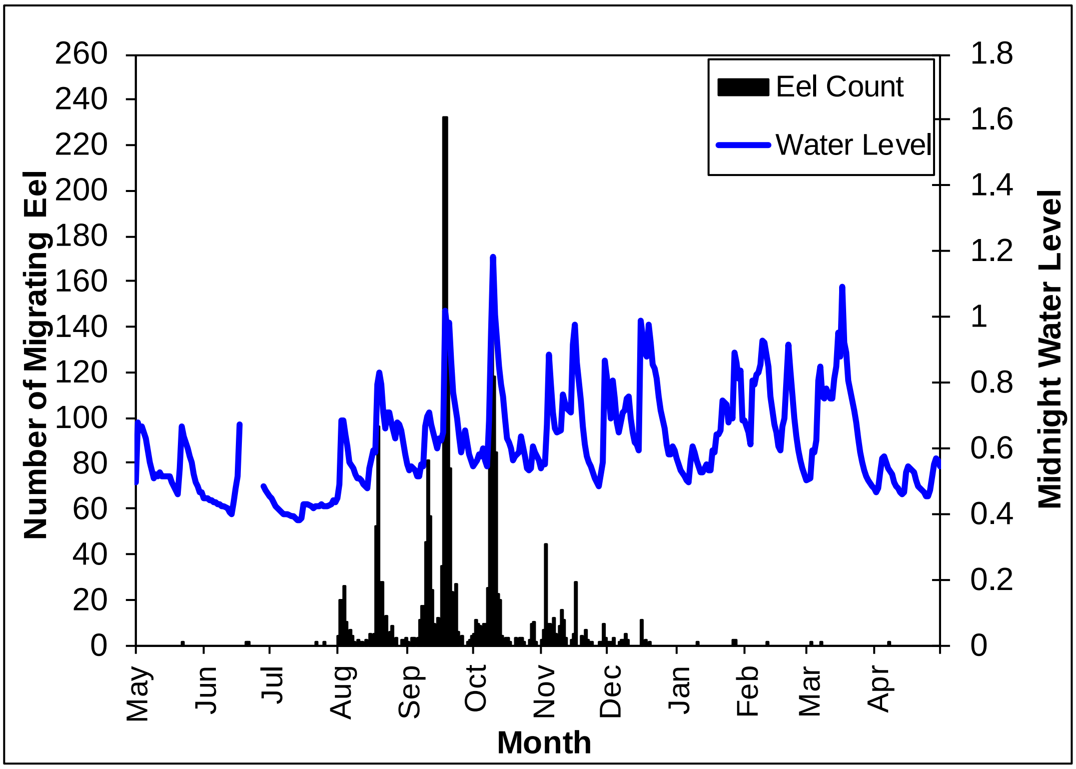

Figure 7-1: Daily counts of downstream migrating silver eel and mid-night water levels (m), May 2018 to April 2019.

Table 7-2: Comparative data for the silver eel runs since 1971.

Years	Number Sampled	Mean. Weight (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1991 - '95	3441	227
1996 - '00	3958	212
2001 - '05	3201	215
2006	493	225
2007	571	201
2008	796	234
2009	220	209
2010	982	192
2011	1835	180
2012	3315	163
2013	1301	157
2014	650	196
2015	366	192
2016	554	177
2017	481	177
2018	573	178

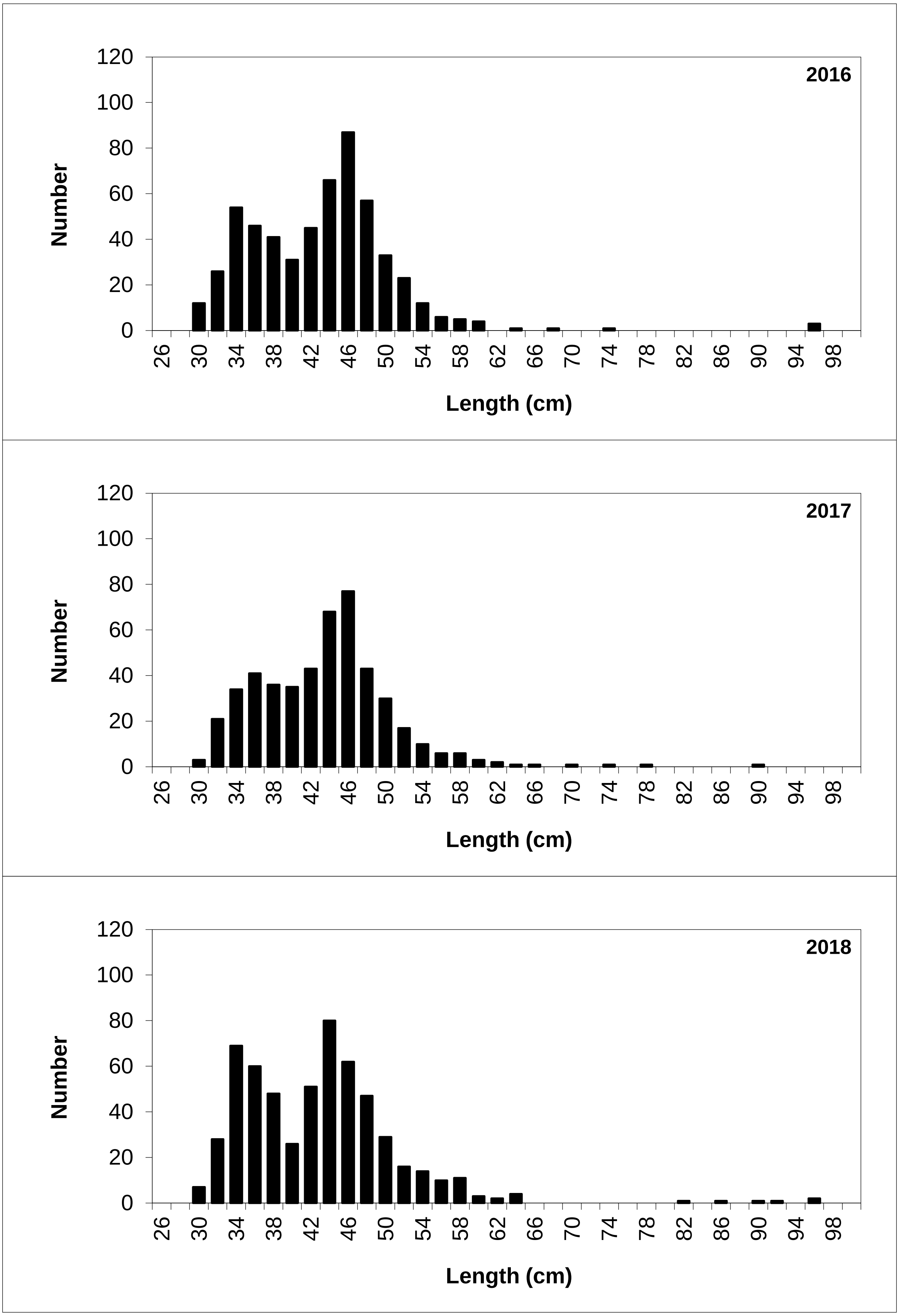

Figure 7-2: Length frequency of sub-samples of silver eels trapped in the downstream traps, 2016 (n=554), 2017 (n=481) and 2018 (573).

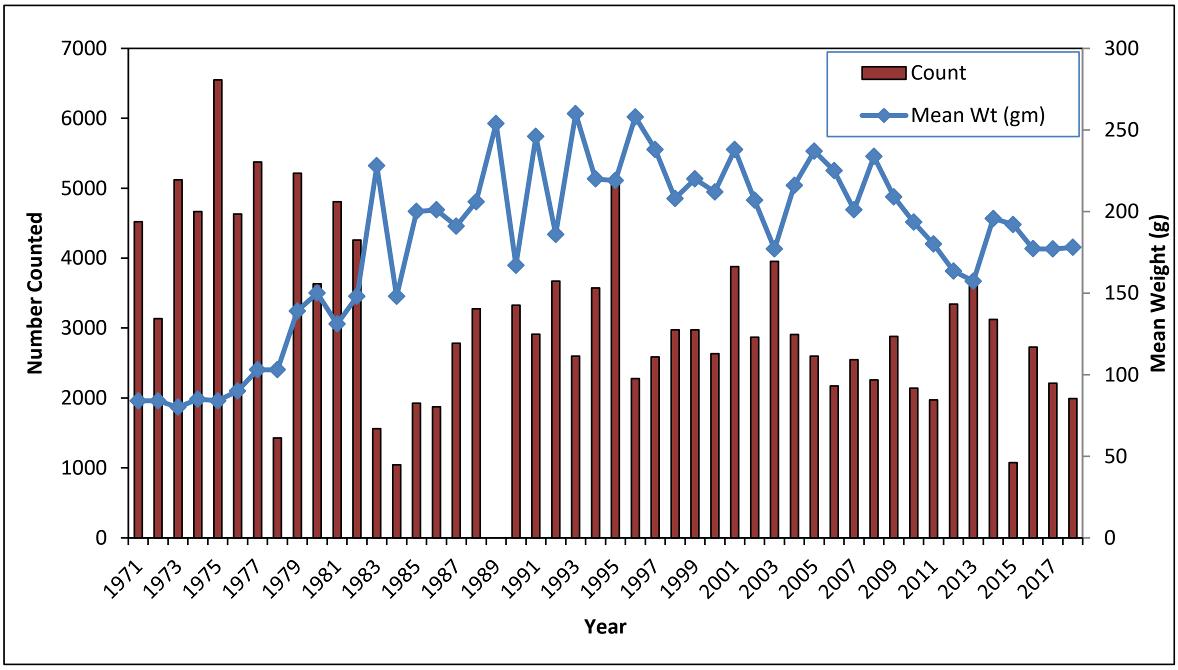

Figure 7-3: Annual number and mean weight of silver eels trapped in the downstream traps.

8 Fishery Report - Catch Data

The Burrishoole Fishery is a valuable part of the overall stock census programme and is run as an integral part of the monitoring programme. As part of the conservation of the Burrishoole wild stock, changes to the active season and to the parts of the catchment being fished have caused differences, or gaps, in the data being collected. Lough Feeagh, which had been closed to angling since 1997 for conservation reasons was opened to angling for the month of September in 2008, on a catch and release basis for wild fish. In 2009 - 2013 Lough Feeagh was open for angling on a catch and release basis from August to the end of September and in 2014 for one week only from 24th August due to low stock. In 2015 Lough Feeagh was open from August 12th to the end of September and Lough Furnace was open to angling from 17th of June to the 30th September. The fishery was operated on a 5-day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout. During 2016 Lough Furnace was open from June 15th to September 30th. Lough Feeagh was open from 17th August to the end of September. The fishery was again operated on a 5-day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout.

During 2017 Lough Furnace was open from June 14th to September 30th. Lough Feeagh was closed under a conservation byelaw. The fishery was again operated on a 5-day week from Wednesday to Sunday inclusive and on a catch and release basis for wild salmon and sea trout.

During 2018 Lough Furnace was open from June 15th to September 30th. Lough Feeagh opened on the 3rd September. The fishery was operated on a 7-day week and on a catch and release basis for both wild salmon and sea trout.

8.1 Numbers and Average weight of Rod Catch

The Lough Furnace rod catch in 2018 consisted of 10 wild fish and 32 reared fish. All wild caught fish were returned alive. The first reared fish was caught on June 17th and the first wild fish on 19th July.

The average weight of reared fish was 1.7kg (n = 31) and the heaviest fish was 3.0kg. No lengths or weights are available for wild fish due to catch & release being in place.

A total of 6 sea trout were caught on Lough Furnace. Regulations remained in place whereby all rod caught sea trout were returned alive.

A total of 698 brown trout were caught on Lough Feeagh.

8.2 Timing of Catch and Rod Effort

The main feature of the 2018 angling season was the low rainfall and consequently low freshwater flows during June and July and the relatively high water temperatures. The first wild salmon was not caught until July 19th and this may have been a consequence of the low freshwater outflow and the high salinity stratification of Lough Furnace during this period. Unlike recent years when water levels were high during the angling season, water levels were very low during June and July.

Table 8-1: Wild and reared salmon rod catch and rod effort (hours) for the 2018 season for L. Furnace and L. Feeagh.

Furnace

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	3	105
July	2	5	381
August	8	24	314
September	0	0	20
Total	10	32	820

Feeagh

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	7	2	245
Total	7	2	245

8.3 Exploitation Rates of Rod Fishery

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2. From 1997 onwards Lough Feeagh was closed to angling. Exploitation rates are only available for Lough Furnace since 1997. The cessation of angling on Lough Feeagh was due to the continuing low stock level of wild fish. Following the cessation of drift netting in 2007 and the increased return of wild fish it was decided to re-open Lough Feeagh in 2008 to angling for the month of September only on a catch and release basis for both wild and ranched fish. Since 2008, and in future years, the running of a fishery on L. Feeagh was reviewed each year and was dependent on sufficient wild stock being present. In 2017 Lough Feeagh was closed to angling as the stock was below the limit permitted for Catch & Release.

No sea trout angling was permitted on L. Feeagh between 1997 and 2008 and since 2008 up to 2016 the fishery has been open on a limited basis. In 2017 sea trout angling was not permitted.

Anglers fishing on Lough Furnace were requested to return wild salmon alive to the water. Injured or damaged wild fish were permitted to be retained however no fish were retained in 2017. The fishery was open in both Furnace and Feeagh in 2018 on a strictly catch and release basis for both salmon and trout.

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2010 to 2018 are shown in Table 8.2.

Table 8-2: Rod fishing exploitation rates (2010-2018). [1] based on total catch; [2] based on catch killed.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
WILD SALMON									
Lough Feeagh									
"Available" fish by end of fishing season	691	516	683	694	145	632	461	*	310
Total rod catch	8	13	28	16	0	19	12		7
Rod catch retained	0	0	0	0	0	0	0		0
Angling success %[1]	1.15	2.5	4.10	2.31	0.00	3	2.6		2.3
Exploitation rate %[2]	0	0	0	0	0	0	0		0
WILD SALMON	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Loughs Feeagh & Furnace									
Total stock of wild fish	703	571	686	734	305	650	548	541	330
+ 10% addition for L. Furnace population	773	628	755	807	336	715	602	595	363
Total catch of wild fish	26	36	50	35	8	28	17	12	17
Rod catch retained	0	0	0	1	0	0	0	0	0
Max. angling success %	3.7	6.3	7.3	4.8	2.6	3.9	3.1	2.2	5.2
Min. exploitation rate	0	0	0	0.1	0	0	0	0	0
Max. exploitation rate	0	0	0	0.1	0	0	0	0	0
REARED SALMON	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Lough Feeagh									
"Available" fish by end of fishing season	130	125	128	105	117	101	109	*	143
Total rod catch	1	1	3	1	0	2	3		2
Rod catch retained	0	0	0	0	0	0	0		0
Angling success %[1]	0.8	0.8	1.5	1.0	0.0	2	1.5		1.4
Exploitation rate %[2]	0	0	0	0	0	0	0		0
Loughs Feeagh & Furnace									
Total stock	940	1293	2392	1301	1205	1931**	1245	1212	2019
Total rod catch	79	86	78	71	40	25	47	57	34
Exploitation rate %	8.4	6.7	3.3	5.5	3.3	1.3	3.8	3.3	1.7
WILD SEA TROUT	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Lough Feeagh									
"Available" fish by end of fishing season	71	58	129	60	140	58	80	*	20
Rod catch	1	1	5	12	19	30	28		0
Exploitation rate %	0	0	0	0	0	0	0		0
Angling Success %	1.4	1.7	3.9	20.0	13.6	51.7	35.0		0.0

* Fishery closed; ** due to the flooding issue in November & December, this figure is based on the total return of reared fish processed for tags

8.4 Angling Success

Table 8.3 presents the Catch per unit effort (CPUE) which is the number of fish caught per rod day, and the Effort per unit catch (EUPC) which is the number of rod days it takes to catch a fish.

Table 8-3: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery based on an eight hour fishing day. Salmon includes both wild and reared.

	Lough Furnace				Lough Feeagh			
	Salmon		Sea Trout		Salmon		Sea Trout	
Year	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
'80-'84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
'85-'89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
'90-'95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
'96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90
'97	0.17	6.00	0.10	9.60	*	*	*	*
'98	0.44	2.30	0.08	13.20	*	*	*	*
'99	0.09	10.80	0.05	20.80	*	*	*	*
'00	0.30	3.31	0.06	16.50	*	*	*	*
’01	0.15	6.70	0.12	8.40	*	*	*	*
’02	0.12	8.30	0.07	15.30	*	*	*	*
’03	0.13	7.60	0.06	17.70	*	*	*	*
’04	0.22	4.60	0.16	6.30	*	*	*	*
’05	0.26	3.80	0.08	13.00	*	*	*	*
’06	0.44	2.30	0.04	23.50	*	*	*	*
’07	0.49	2.10	0.14	6.90	*	*	*	*
’08	0.35	2.89	0.05	21.60	0.46	2.18	0.07	13.80
’09	0.18	5.66	0.24	4.09	0.21	4.75	0.42	2.38
’10	0.60	1.66	0.14	7.27	0.82	1.22	0.09	11.00
'11	0.68	1.47	0.35	2.8	1.06	0.95	0.08	13.10
’12	0.96	1.04	0.10	10.10	1.10	0.91	0.18	56.62
'13	0.66	1.51	0.22	4.5	0.60	1.70	0.42	2.40
’14	0.32	3.17	0.35	2.9	0.00	0.00	0.18	5.60
’15	0.23	4.31	0.17	5.75	0.40	2.50	0.56	1.77
’16	0.31	3.18	0.13	7.41	0.38	2.6	0.72	1.4
’17	0.39	2.57	0.03	29.5	*	*	*	*
’18	0.41	2.44	0.06	17.08	0.29	3.4	0	0

9 Catchment Stock Assessment

9.1 Introduction

The Burrishoole catchment, upstream of the main fish traps, has been monitored since 1990 with surveys of the salmonid and eel stocks taking place in the rivers and the main lakes. Electrofishing, with 3-fishing depletions, is used for salmonids and eels in the streams, fine mesh beach seines are used for salmonids in the lakes and summer fyke nets are used for eels in the lakes. Eel surveys are also undertaken in the tidal waters below the traps.

9.2 Electrofishing Surveys

2018 marked the completion of 28 years of electrofishing surveys in the Burrishoole and Owengarve catchments. Densities of eels and juvenile salmonids were calculated using three pass removal sampling.

As in 2017, poor weather conditions in 2018 again severely hampered our efforts at a catchment wide survey, and only 21 sites in the Burrishoole were fished in total. Sites were fished between the 13th August and the 5th September. A total of 2193 fish were caught and measured over the 21 sites, although it should be noted that five of the Rough river sites (1-5) had been stocked for experimental purposes and should not be considered as part of natural stock recruitment. The 21 sites comprised 2033m^2 of representative habitat. Summary data are presented in Figures 10.1-10.6, and these show the distribution of fish densities around the catchment for eel (Fig. 9.1), 0+ salmon (Fig. 9.2), 1+ salmon (Fig. 9.3), 0+ trout (Fig. 9.4), 1+ trout (Fig. 9.5) and 2+ trout (Fig. 9.6).

The average eel density was 0.01 fish/m^2, with eels recorded in 9 sites out of 21.

Average density of 0+ salmon was 0.53 fish/m^2, with catches recorded in 12 sites. However, 5 of these sites (Rough river 1-5) were stocked for experimental purposes, and when these are excluded, the average density is 0.37 fish/m^2. 1+ salmon were also recorded in 11 sites, with an average density of 0.06 fish/m^2 (0.035 fish/m^2. It should be noted that of the 21 sites fished, 8 would be either inaccessible or inhospitable to salmon.

Average densities of 0+, 1+ and 2+ trout were 0.35, 0.17 and 0.02 fish/m^2 respectively. As with salmon, trout were also stocked in the Rough river for experimental purposes in 2016 and 2017, between the trap and the water fall, and without these sites, the average densities of 0+, 1+ and 2+ trout in the remaining 16 sites was 0.42, 0.17 and 0.02 fish/m^2. 0+ trout were recorded in all 21 sites, while 1+ trout occurred in 20 sites, and 2+ trout were recorded in 12 sites.

Average densities of 0+ trout were higher to those recorded in previous years. (Fig. 9.7), as were the densities of 0+ and 1+ salmon. The density of eel was slightly high than last year.

9.3 Beach Seine Surveys

Beach seine surveys were not conducted in 2018 (Plate 1) due to high lake levels.

As part of the Cullen PhD on juvenile salmonids (Ross Finlay) a few sites on Bunaveela Lough were fished on two occasions late in the season. The trout were PIT tagged as part of the Bunaveela trout life history project. Table 9.1 gives the details of the numbers of fish captured, tagged and recaptured for each fishing date.

Table 9-1: Summary data for the 2018 beach seine surveys.

Date	Site	No. of Hauls	Trout Tagged	Trout below Tag Size (70mm)	Trout Recap	Salmon Tagged	Salmon Below Tag Size (70mm)	Salmon Recap	Char Caught
24/10	Bunaveela	4	41	6	10	4	3	0	0
08/11	Bunaveela	3	31	3	10	2	0	0	0

Plate 1. Beach seining on Lough Feeagh

9.4 Fyke Net Surveys

9.4.1 Survey Data

Fyke net surveys of yellow eels have been conducted in the 1970s and 1980s as parts of previous studies. The Burrishoole lakes Feeagh and Bunaveela have been incorporated into the National Eel Survey in 2009-2018. Fyke net surveys of the tidal Lough Furnace and 'Back of the House' have been more sporadic or at a lower effort.

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year.

Fyke net surveys carried out between 1960 and 2008 provide a useful bench mark against which to assess the changes in stock. The yellow eel monitoring strategy will rely on the use of standard fyke nets. Relative density will be established based on catch per unit effort.

Bunaveela Lough is located in the upper reaches of the catchment. It has a surface area of 42ha and a maximum depth of 23m. Bunaveela L. was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2018 (27-28 June 2018), with chains of 10 nets fished at six sites. In total 13 eels were caught with a catch per unit of effort of 0.22 eels/net/night (Table 9.2). The average length was 44.2cm and ranged in length from 32.8cm to 59.6cm. Thirteen eels were PIT tagged and no recaptures were made of previously tagged fish.

Lough Feeagh has a surface area of 395ha and an average depth of 14.5m (with several areas >35m in depth). L. Feeagh was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2018 (3-4, 31 July 2018), with chains of 10 nets fished at six sites for one night each and 3 sites repeated later in the month. In total, 83 eels were caught with a catch per unit effort (CPUE) of 0.92 eels/net/night (Table 9.2). The average length of eels was 45.2cm and ranged in length from 29.1cm to 96.1cm, with a total weight of 17.97 kg caught in the three nights. Most of the catch (77) was PIT tagged and eight previously tagged eels were recorded. Six eels were sacrificed in this survey. Four of the six (66.7%) of the eels contained *A. crassus* with an infection intensity of 4.0.

Lough Furnace, the tidal lough, has a surface area of 125ha north of Nixon's Island and 16ha between Nixon's Island and the mouth of the estuarine river (Lower Lough Furnace). The main lough has a maximum depth of 21.5m. Furnace is heavily stratified with significant areas of deoxygenated water in the main basin. L. Furnace was fished in the traditional style (sets of 10 nets perpendicular to the shore) in 2018 (10-11 July), with chains of 10 nets fished at six sites in one night each and one night (3 August). Three chains of nets were fished at the Back of the House (20 June), which is a shallow tidal area between the lough and the estuarine river.

In L. Furnace, 91 eels were caught with a catch per unit effort (CPUE) of 1.01 eels/net/night (Table 9.2). The average length was 40.1cm and ranged in length from 28.1cm to 70.7cm. A total weight of 11.19kg was caught.

In the Lower Lough Furnace, only 6 eels were caught with a catch per unit effort (CPUE) of 0.2 eels/net/night (Table 9.2). The eels average length was 51.4cm and ranged in length from 33.7cm to 59.9cm, with a total weight of 1.44 kg caught.

One night was fished in the estuary, with three chains of 10 nets set (19 June 2018). This was the first survey at this location since 1988. Six eels were caught with a catch per unit effort (CPUE) of 0.2 eels/net/night (Table 9.2). The average length was 38.8cm and ranged in length from 33.7cm to 49.0cm. A total weight of 0.56kg was caught.

Six eels were sacrificed in this survey from Lough Furnace. One of the six (16.7%) of the eels contained *A. crassus* with an infection intensity of 13. *A. crassus* has been established in the lough since about 2011.

Six eels were sacrificed in this survey from Lower Lough Furnace. Five of the six (83.3%) of the eels contained *A. crassus* with an infection intensity of 7.6.

Five eels were sacrificed in this survey from the estuary. One of the five (20.0%) of the eels contained *A. crassus* with an infection intensity of 5.

Table 9-2: Catch details of the standard yellow eel survey in 2018. Net (pair of traps).

Lake	Dates	No. Eels	Net* Nights	CPUE	Total weight (kg)	Mean length (cm)	Mean weight (Kg)
Bunaveela	27-28/06/2018	13	60	0.22	2.28	44.2 (32.8-59.6)	0.176
	2018	**13**	**60**	**0.22**	**2.28**	**44.2 (32.8-59.6)**	**0.176**
Feeagh	3-4/07/2018	44	60	0.73	8.67	42.7 (29.1-96.1)	0.197
	31/07/2018	39	30	1.30	9.30	48.1 (32.5-88.2)	0.238
	2018	**83**	**90**	**0.92**	**17.97**	**45.2 (29.1-96.1)**	**0.216**
Furnace	10-11/07/2018	65	60	1.08	8.01	40.24 (28.1-70.7)	0.123
	03/08/2018	26	30	0.87	3.18	39.8 (31.3-55.5)	0.122
	2018	**91**	**90**	**1.01**	**11.19**	**40.1 (28.1-70.7)**	**0.123**
Lwr Furnace (BOH)	20/06/2018	6	30	0.20	1.01	51.4 (33.7-59.9)	0.239
	2018	**6**	**30**	**0.20**	**1.44**	**51.4 (33.7-59.9)**	**0.239**
Estuary	19/06/2018	6	30	0.20	0.56	38.8 (49.0-33.7)	0.112
	2018	**6**	**30**	**0.20**	**0.56**	**38.8 (49.0-33.7)**	**0.112**

9.4.2 Quantitative Eel Survey

The quantitative survey was not fished in 2018.

9.4.3 *Anguillicola crassus*

Anguillicola crassus is an indigenous parasitic nematode of the Japanese eel *Anguilla japonica* in Asia. *A. crassus* does not cause serious pathological damage in its natural host. However, infections in European eel are potentially more serious and can cause damage to the swimbladder with associated bacterial damage, red and swollen anus, as well as, in most severe cases, the collapse of the swimbladder lumen.

A. crassus was introduced into Europe in the early 1980s and it has since spread widely and has successfully colonized most European countries. It was first recorded in Ireland (Waterford Harbour) in 1997. Later records came from the Erne catchment in 1998 and it is now present in approximately 74% of the wetted area of Ireland. The most likely infective route to Ireland was the commercial eel trade although localised spread can be through natural eel movements and paratenic hosts.

The Burrishoole catchment remained free of the parasite until recently. In the fyke net survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus.* Samples of yellow eels from L. Feeagh were negative and a comprehensive sample of silver eels from the traps was also negative indicating that in 2012 the infection seemed to be confined to the tidal lough. This was somewhat surprising as a number of environmental factors have been shown to influence *A. crassus* infections. High salinity has been shown as having a negative impact in the egg hatching and larvae survival of the parasite although the effects of water salinity remain unclear as various surveys have shown no differences in infection levels in waters with different salinity values.

Examination of previous samples would indicate that the parasite was likely to have been introduced into L. Furnace in 2010 or early 2011 (Table 9.3).

The infection intensity in L. Furnace eels continued to rise in 2014 and it was also detected in yellow eels in the Mill Race channel in 2014. The prevalence in 2017 remained at 67% although the intensity increased to 20.7.

The first detection in freshwater was made in 2016 with 10 silver eels (36%) migrating out of the catchment containing the parasite (Table 9.3).

In 2017, the infection had increased to 67% in Lough Feeagh and 65% in the out-migrating silver eels, which had an intensity of 7.2.

In 2018, the infection in freshwater was similar to that in 2017. In saline water, the prevalence was lower in Furnace and a high prevalence was observed in a sample of 6 eels taken from the Back of the House. One eel in the estuary was also infected.

9.5 Long-term biological monitoring in the Burrishoole catchment

Macroinvertebrate surveys of 16 index sites were conducted in 2018. 914 individuals from 48 samples were counted and identified, and are recorded in the Catchment Macroinvertebrate Access database for future analysis. Zooplankton and phytoplankton surveys of Feeagh and Furnace were continued in 2018, with monthly samples being collected using standard methods, and preserved for future enumeration and identification.

Table 9-3: Location and sample details for eels in Burrishoole examined for the presence of *Anguillicola crassus*.

Year	Location	No. of eels checked	Stage	No. Infected	Prevalence	Intensity
Freshwater						
2009	Traps	50	Silver	0	0	0
2010	Yellow R.	5	Yellow	0	0	0
2010	Black Lakes	3	Yellow	0	0	0
2010	Glenamong R.	3	Yellow	0	0	0
2010	Feeagh	2	Yellow	0	0	0
2010	Traps	17	Silver	0	0	0
2011	Traps	50	Silver	0	0	0
2011	Feeagh	30	Yellow	0	0	0
2012	Feeagh	4	Yellow	0	0	0
2012	Traps	168	Silver	0	0	0
2013	Traps	106	Silver	0	0	0
2014	Traps	94	Silver	0	0	0
2014	Mill Race Lwr	7	Yellow	4	57.1	2.3
2014	Mill Race Uppr	11	Yellow	2	18.2	1.0
2015	Traps	10	Silver	0	0.0	0.0
2016	Traps	28	Silver	10	35.7	2.0
2017	Feeagh	6	Yellow	4	66.7	2.5
2017	Traps	26	Silver	17	65.4	7.2
2018	Feeagh	6	Yellow	4	66.7	4.0
2018	Traps	53	Silver	36	67.9	7.0
Saline Water						
2008	Furnace	60	Yellow	0	0	0
2009	Fu Nixons	47	Silver	0	0	0
2010	Furnace	10	Yellow	0	0	0
2010	Fu Nixons	50	Silver	0	0	0
2011	Furnace	4	Yellow	2	50.0	1.0
2012	BOH	6	Yellow	6	100.0	2.0
2012	Furnace	10	Yellow	7	70.0	4.4
2013	Furnace	6	Yellow	6	100.0	13.5
2014	Furnace	9	Yellow	5	55.6	17.6
2016	Furnace	12	Yellow	8	66.7	2.7
2017	Furnace	6	Yellow	4	66.7	20.7
2018	Furnace	6	Yellow	1	16.7	13.0
2018	BOH	6	Yellow	5	83.3	7.6
2018	Estuary	5	Yellow	1	20.0	5.0

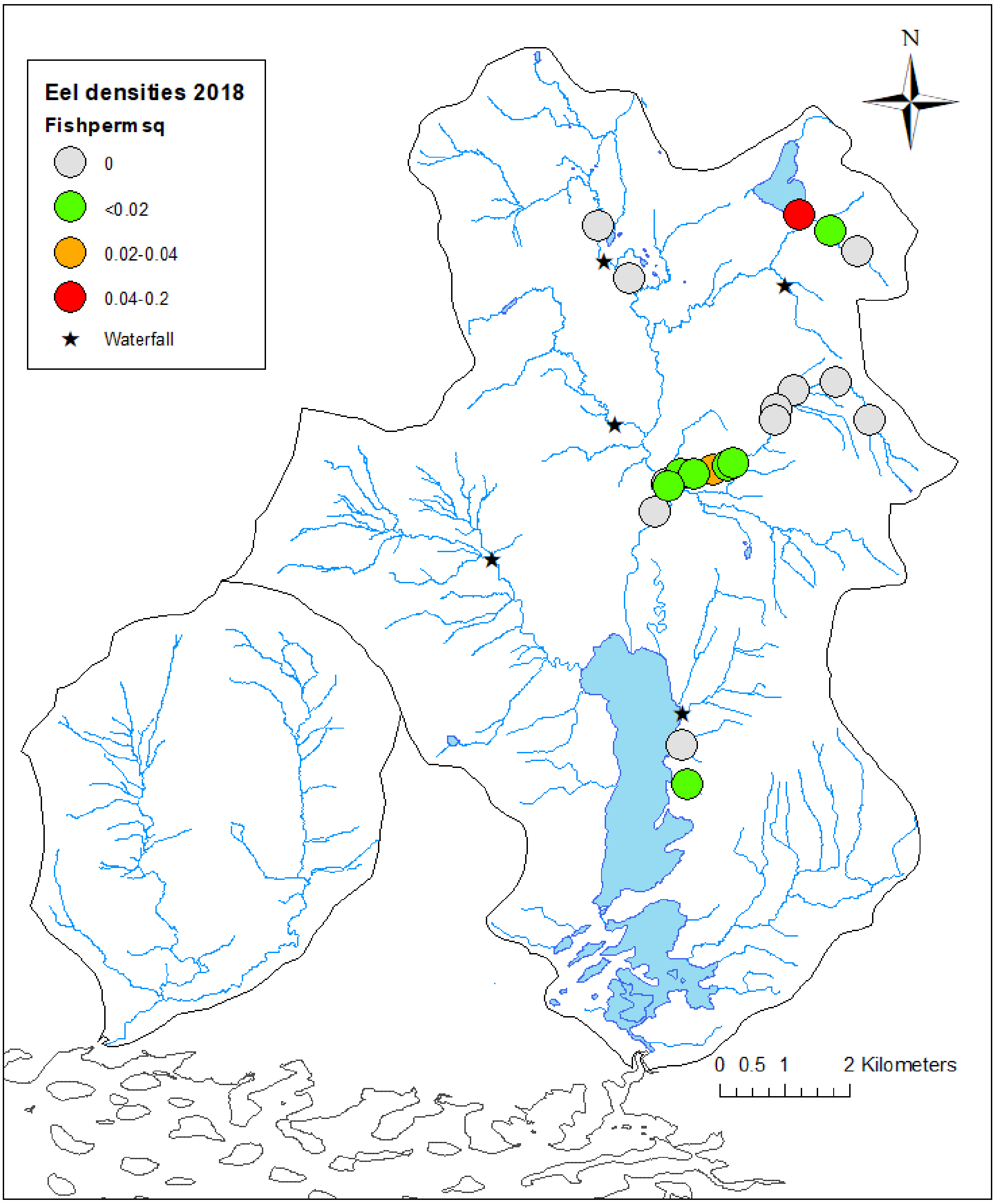

Figure 9-1: Densities of eel calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

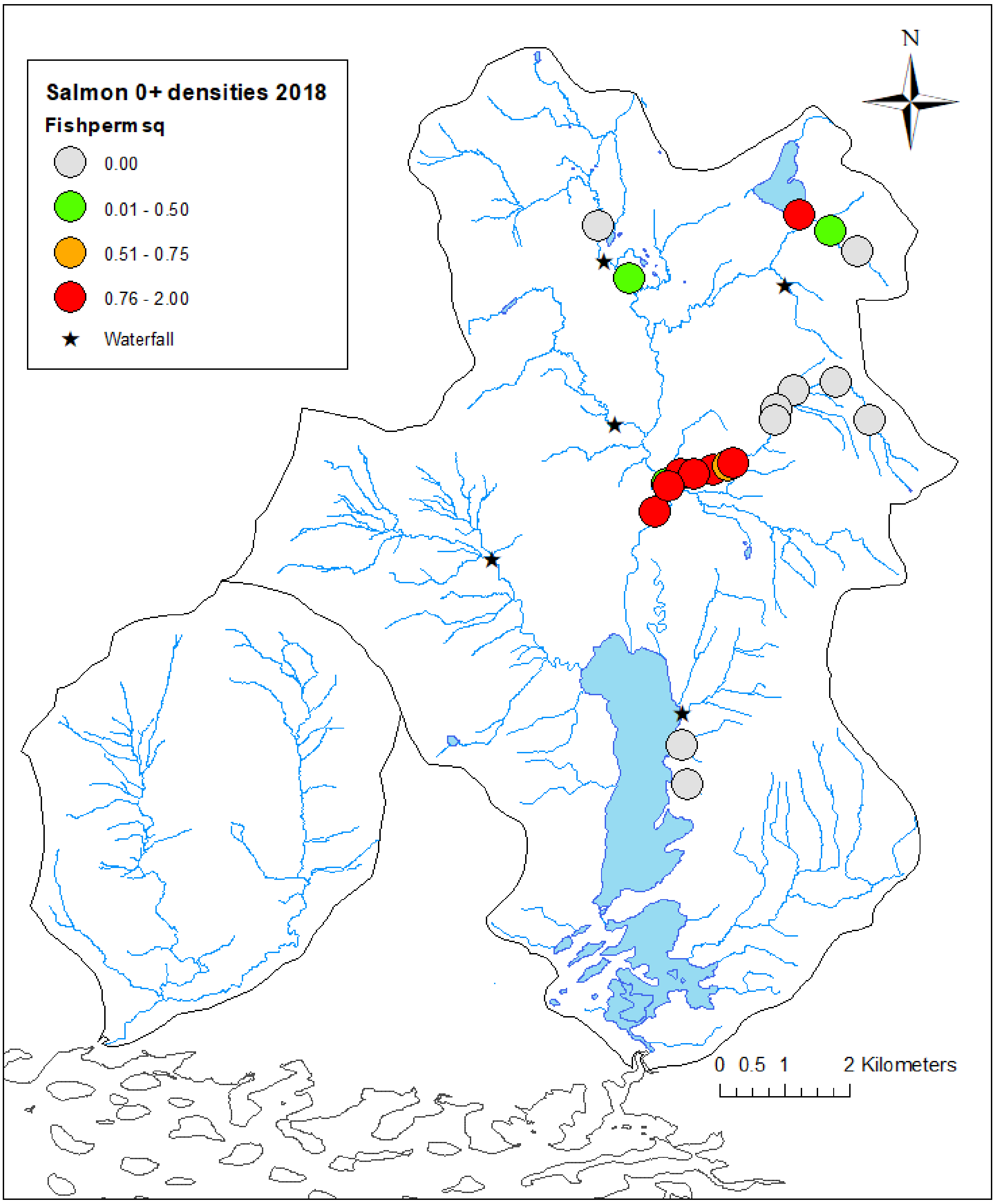

Figure 9-2: Densities of 0+ salmon calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

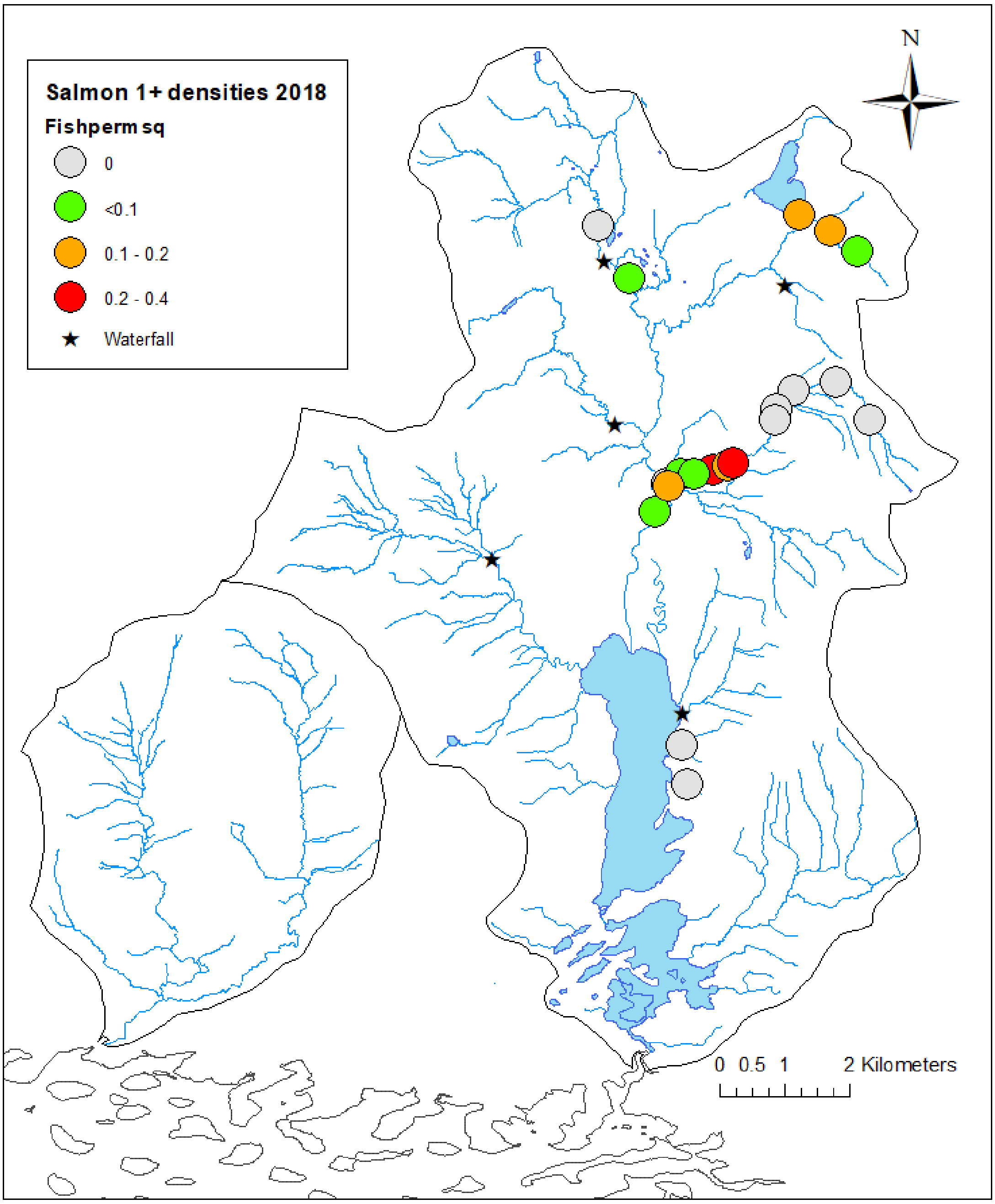

Figure 9-3: Densities of 1+ salmon calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

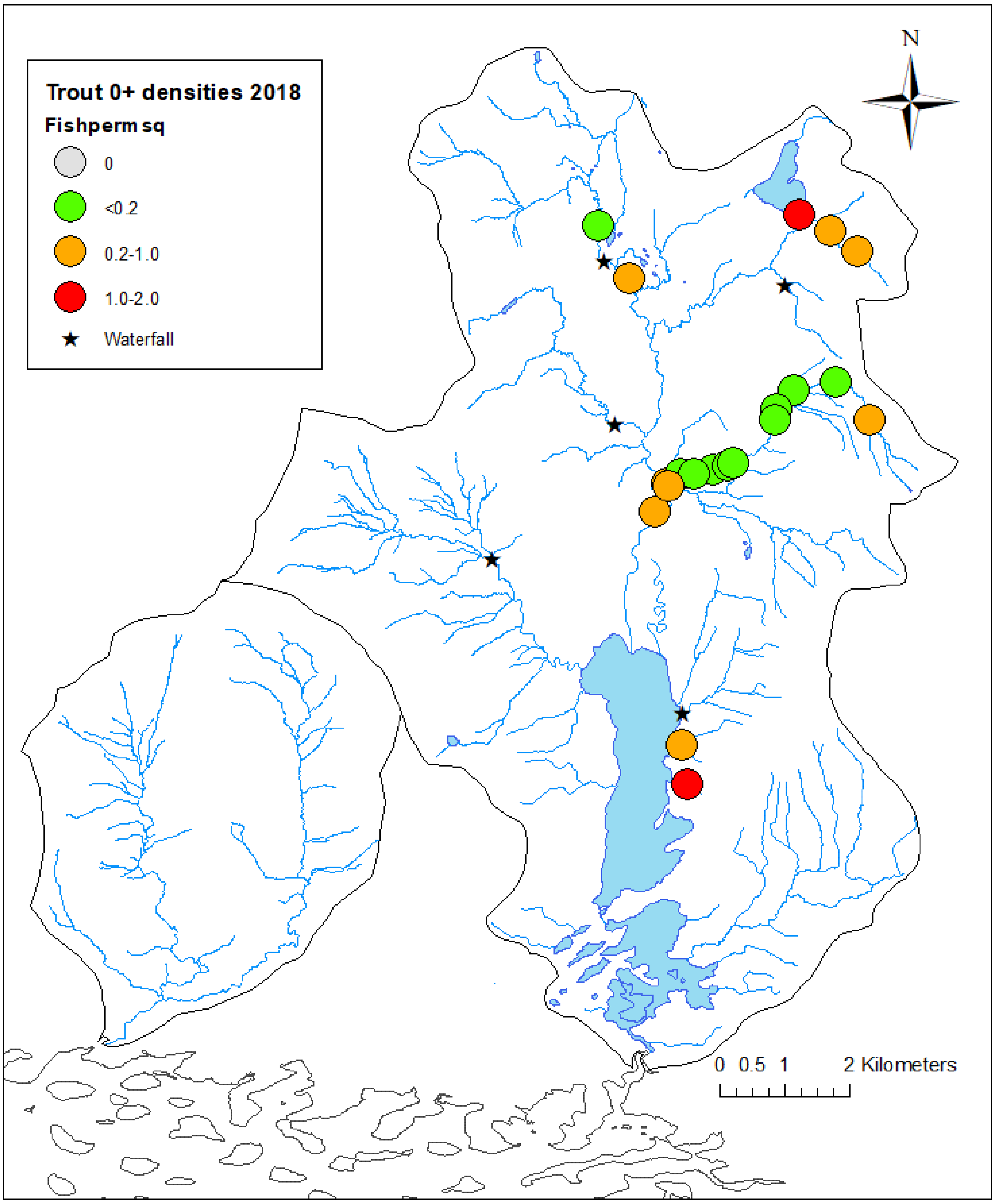

Figure 9-4: Densities of 0+ trout calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

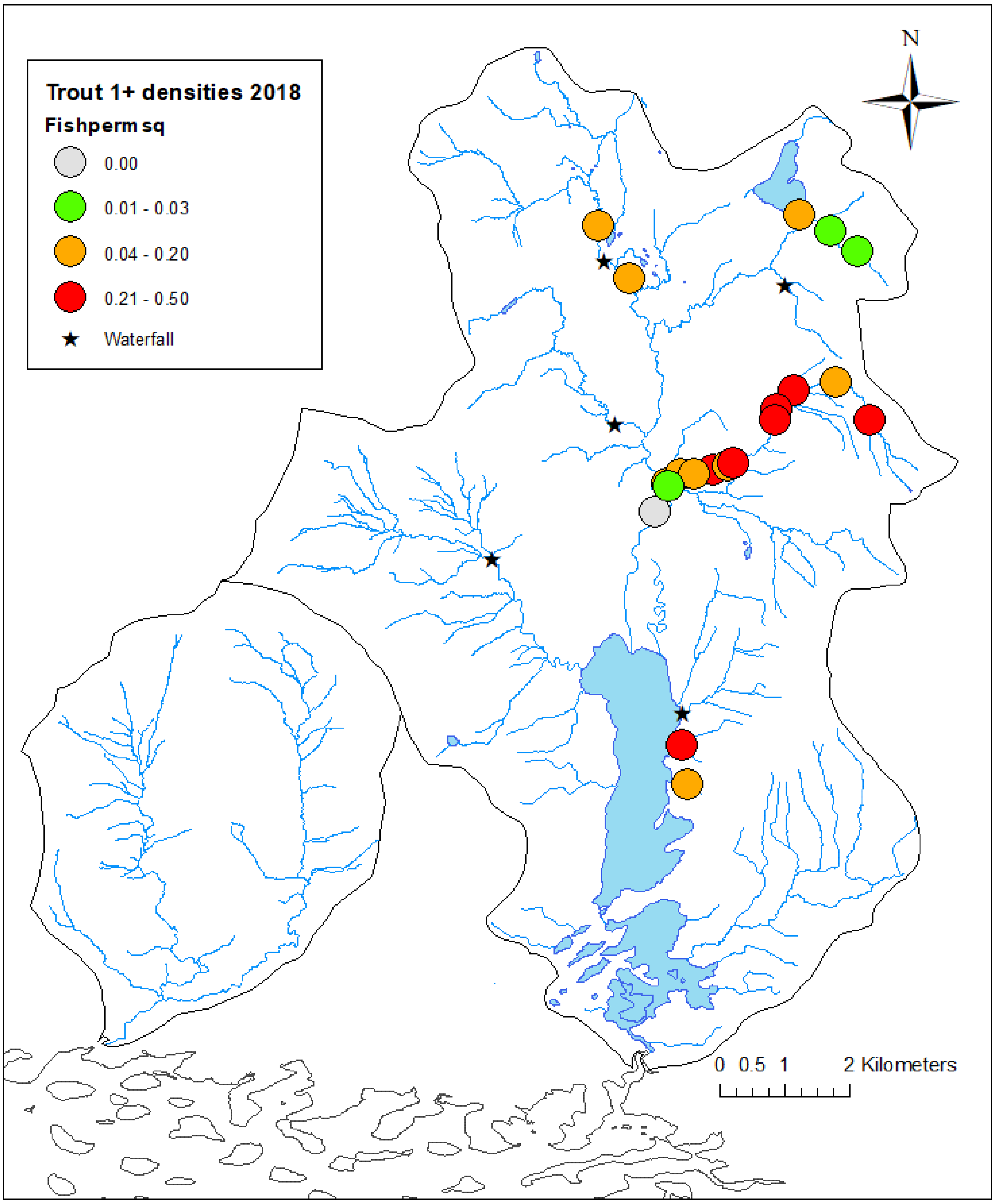

Figure 9-5: Densities of 1+ trout calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

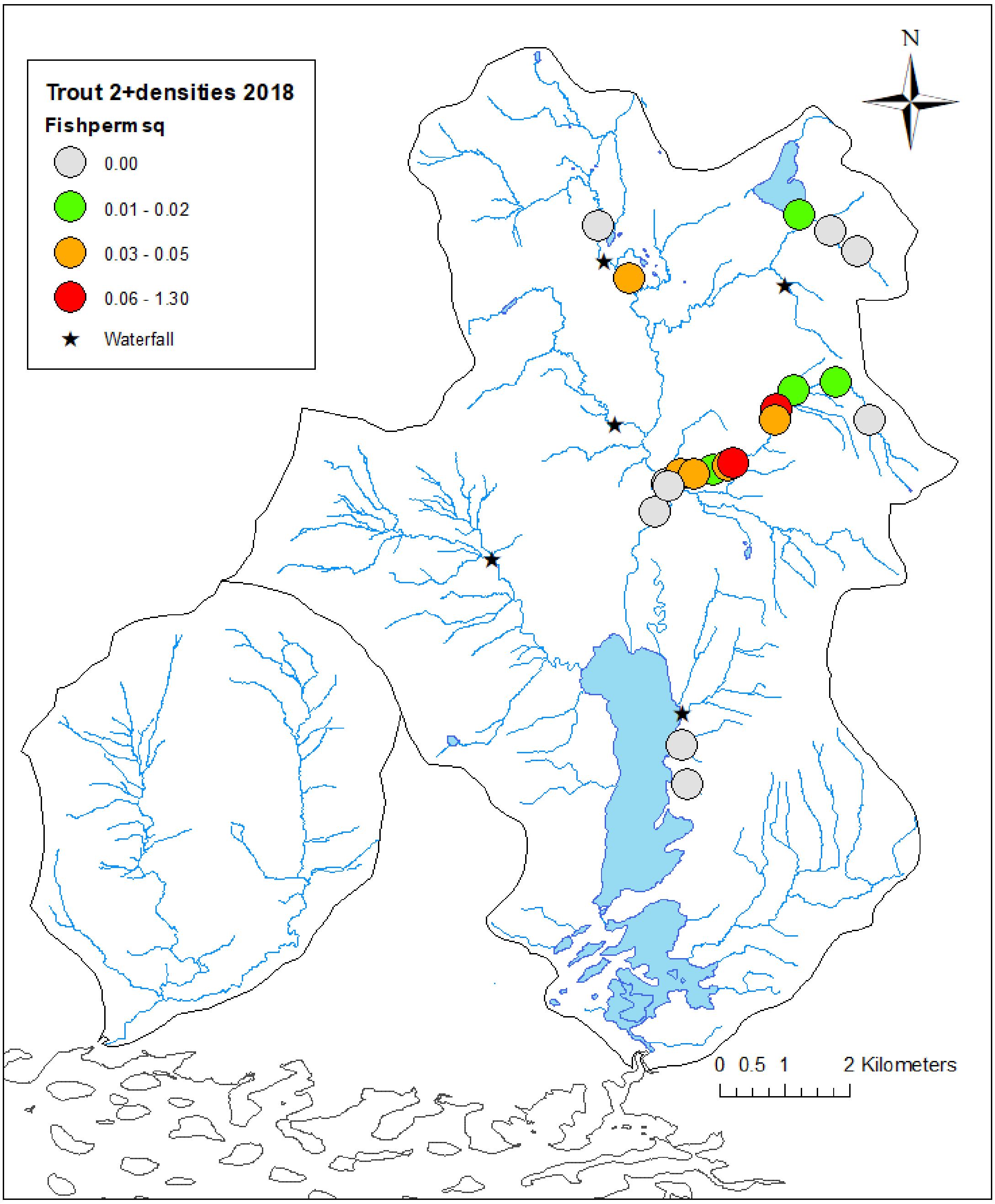

Figure 9-6: Densities of 2+ trout calculated from the 2018 electrofishing survey of the Burrishoole and Owengarve catchments.

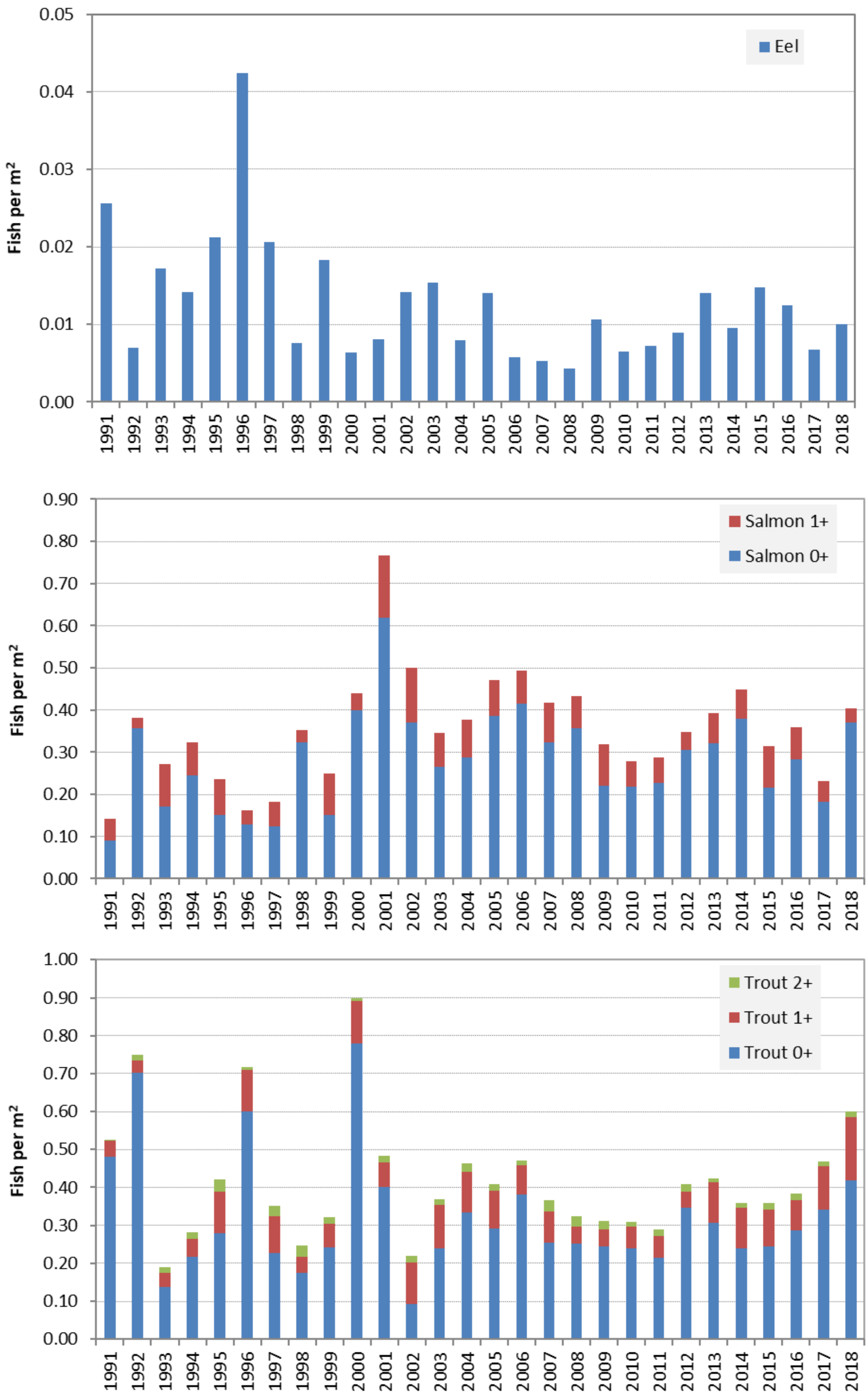

Figure 9-7: Average densities of eel, salmon and trout (fish per m²) calculated from electrofishing surveys of the Burrishoole and Owengarve catchments, 1991-2018. Note that the values for 0+salmon and trout do not include densities from the Rough river, sites 1-5 as these were stocked heavily for experimental purposes.

10 Collaborative Research Programme

10.1 GLEON

In 2007, the Burrishoole catchment became a member of the Global Lake Ecological Observatory Network (GLEON: http://www.gleon.org), an association of limnologists, information technology experts and engineers whose goal is to establish a persistent network of lake ecology observatories (http://www.gleon.org). Work with GLEON working groups continued in 2018. There was a large Irish contingent at the GLEON 20 meeting in Australia, representing the many diverse collaborative projects we are involved in. Data from the Burrishoole catchment are being used in several GLEON working groups, including those focussed on signal processing of high frequency lake data, the role of catchment processes and dynamics on lake metabolism and the role of lakes in the global carbon cycle. Elvira de Eyto served her third years on the steering committee. During 2018, we carried out field work for a GLEON project, DC-FLUX, which seeks to characterise CO2 emissions from lakes over 24 hour periods. Sampling trips were carried out in March and June 2018, and data are being collated.

10.2 Cullen PhD Fellowships

In 2015, a call was put out for four PhD fellowships to be awarded for projects based in Burrishoole. Sean Kelly commenced his project in October 2015, and three others started in 2016.

The projects are as follows:

Brian Doyle (E. Jennings, DKIT): Resolving the Organic Carbon Budget of a salmonid humic lake.

Sean Kelly (M. White, NUIG): To investigate the dual influence of marine water and freshwater on the hydrography and related ecology of a coastal lagoon, Lough Furnace, Co. Mayo.

Aisling Doogan (D. Brophy, GMIT): Investigation of the causes of early migration mortality in salmon and sea trout from the Burrishoole National Index River using acoustic telemetry in freshwater and coastal areas.

Ross Finlay (T. Reed, UCC): Investigation of the early migration of salmon and brown trout from the Burrishoole National Index River using PIT tag technology in freshwater and brackish areas

By the end of 2018, all four projects were progressing as planned.

10.3 PROGNOS

In 2016, we commenced the PROGNOS project, which is financed under the ERA-NET Cofund WaterWorks2014 Call. This ERA-NET is an integral part of the 2015 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI). Irish funding to the two partners (Marine institute and Dundalk IT) comes from the EPA. In PROGNOS, we are developing an integrated approach that links high frequency (HF) lake monitoring data to dynamic water quality models to forecast short-term changes in nuisance algal blooms and higher levels of dissolved organic carbon (DOC). This will potentially provide a greater window of opportunity over which to make water quality management decisions, and will increase the value of HF monitoring data, ensuring that their potential to guide water quality management is fully realised. The project consortium includes expertise from European sites that have been involved in the forefront of HF monitoring systems since the late 1990s, expertise in modelling algal blooms and DOC levels, and expertise in assessing societal benefits from changes in water management. Lough Feeagh will be used as a DOC case study. Tadhg Moore continued his PhD with the project team, registered in DkIT under the supervision of Eleanor Jennings (DkIT) and Elvira de Eyto (MI), and has made significant progress in 2018. The third annual PROGNOS meeting was held in Aarhus, Denmark, in June 2018. More information can be found on the PROGNOS website (http://prognoswater.org/), including an informative blog section.

10.4 DETECT

DETECT is an Environmental Protection Agency funded project that aims to develop an Assessment Framework to support the identification of the principle stressors constraining ecological recovery in water bodies. The MI is a partner in the project, with a small role providing data from the long term ecological monitoring of the Burrishoole catchment. This project ceased to be funded in 2018, due to difficulties outside of the control of the MI partners.

10.5 WATExR

In 2017, work began on the WATExR project, which is part of ERA4CS, an ERA-NET initiated by JPI Climate, and funded by MINECO (ES), FORMAS (SE), DLR (DE), EPA (IE), IFD (DK), RNC (NO) with co-funding by the European Union (Grant 690462).
It will run from 2017 to 2020. The aim of the project is to integrate state-of-the-art climate seasonal prediction and water quality simulation in a QGIS-based advanced solution to ensure efficient decision making and adaptation of water resources management to an increased frequency of climate extreme events. The project started in September 2017, with a kck-off meeting in ICRA Girona. The MIs role is to conduct the modelling work for the Burrishoole catchment, primarily focussing on using seasonal forecasts to predict fish phenology. Andrew French strated as a postdoc on this project in February 2018 and made significant progress on collating and modelling fish phenology data from Burrishoole. The annual meeting was held in Magdeburg in November 2018. More information can be found here: https://watexr.eu/

10.6 MANTEL

The Marine Institute is a partner in the MANTEL project which is a Marie Sklodowska-Curie Action. MSCAs provide funding for research-focussed organisations, such as universities, research centres and companies, to host foreign researchers and to create strategic partnerships with leading institutions world-wide. Innovative Training Networks (ITNs) are one area which are funded through MSCAs. ITNs support competitively selected joint research training and/or doctoral programmes implemented by European partnerships of universities, research institutions and non-academic organisations. The aim of ITNs is to boost scientific excellence and business innovation and enhance researcher career prospects through developing their skills in entrepreneurship, creativity and innovation. European Joint Doctorates (EJDs) are one of the three types of ITNs. EJDs require a minimum of three academic organisations to form a network with the aim of delivering joint, double or multiple degrees. The aim of an EJD is to promote international, intersectorial and multi-interdisciplinary collaboration in doctoral training in Europe. In addition to organisations from different EU or associated countries, the participation of additional organisations from anywhere in the world, including from the non-academic sector, is encouraged. This is the role of the Marine Institute, as MANTEL is training a cohort of 12 PhD students, many of whom will use data collected in Burrishoole, and carry out secondments here. MANTEL kicked off in 2017, and recruited throughout the year. Most of the students were in place by the end of 2017. More information can be found here https://www.mantel-itn.org/.

10.7 Other catchment

During 2018, the catchment team continued collecting samples for inclusion in the GNIR (Global Network of Isotopes in Rivers - http://www-naweb.iaea.org/napc/ih/IHS_resources_gnir.html). GNIR is a global environmental observation programme dedicated to the compilation of isotopic assays of water, nutrients and particulate and dissolved constituents in global river systems. GNIR serves as an essential world-wide repository for riverine isotope data, and facilitates public dissemination of contributed riverine isotopic data through a cost-free user-friendly web portal. GNIR is a complimentary programme to the IAEA (International Atomic Energy Agency) well-established Global Network of Isotopes in Precipitation. Monthly samples are taken from the Black and Mill Race rivers, and dispatched to the IAEA facility in Vienna for analysis.

During 2015, we were involved in another collaborative project CELLDEX, the aim of which was to understand biological degradation across the globe using a standardised protocol. This project is being led by Scott Tiegs of Oakland University, Rochester, United States. Fieldwork for this project was carried out in 2015 and early 2016, and data were collected and analysed in 2017. A publication on the work was prepared in 2018, and published in early 2019.

We also took part in a similar project DECODIV, through our ongoing collaboration with UCC and Prof. Paul Giller. The DECODIV project aims to investigate leaf litter decay in headwater streams across the globe using a standardised methodology. The project is being led by Luz Boyero, University of the Basque Country. Fieldwork commenced late in 2017, and data are currently being collated and analysed.

Of particular note is the inclusion of data from Lough Feeagh (Mill Race surface water temperatures) in an annual publication "The State of the Climate in (year)" which is produced every year by the *Bulletin of the American Meteorological Society.* We started contributing data to this publication in 2016, (for the 2015 period), and have now contributed to the State of the Climate report for 2015, 2016, 2017 and 2018.

10.8 BEYOND2020

BEYOND 2020 (Burrishoole Ecosystem Observatory Network 2020) is funded under the Marine Research Programme by the Irish Government. It is a multi-institute research cluster that is working with the Marine Institute Newport Catchment Facilities to build on the existing biological and sensor monitoring programme in the Burrishoole catchment in County Mayo by using next generation science and technology to inform ecosystem response to environmental change. The team, from six Irish and UK institutes, aim to maximise and enhance the current capabilities by undertaking new analysis on lake physics and aquatic ecosystem metabolism, modelling environmental variables in the recent past and into the near future, developing Burrishoole as a testbed for new chemical and biological sensors, undertaking new aerial observations using drone technology to inform on marine-freshwater links, and harnessing next generation 'omic science, to understand, predict and communicate the role and response of aquatic ecosystems in a changing global environment. In addition, the cluster will train a set of five postgraduate and four post-doctoral researchers in cutting-edge technologies, thus building capacity and ensuring the place of the Burrishoole Ecosystem Observatory Network at the forefront of national, regional and global network science in the coming decades. The project commenced in 2017 and work is ongoing. More information can be found here: https://www.dkit.ie/beyond-2020. The PIs on the project are Eleanor Jennings (DkIT) and Phil McGinnity (UCC).

10.9 Unlocking the Archive

This project is a collaboration with the Marine Institute, funded under the Marine Research Programme by the Irish Government. An aim of the project is to consolidate national collections of scales, otoliths, associated images and data into a single biochronology repository, thus maximising the use of the archive by researchers. Time series of scale/otolith growth and chemical composition will be analysed within the project to investigate how migratory fish respond to environmental change. The PI on the project is Deirdre Brophy, GMIT.

10.10 Alternative life histories (ALH): linking genes to phenotypes to demography

The Institute are collaborating with University College Cork (Dr Tom Reed), who were awarded funding for five years (2014-2019) by the European Research Council (ERC) to achieve an understanding of how genetic, environmental and physiological factors interactively shape ALH tactics in Brown Trout and how this in turn affects population demography. Project partners are the Marine Institute, Inland Fisheries Ireland and University College Cork (project lead).

Understanding how and why individuals develop strikingly different life histories is a major goal in evolutionary biology. It is also a prerequisite for conserving important biodiversity within species and predicting the impacts of environmental change on populations. The aim of the study is to examine a key threshold phenotypic trait (alternative migratory tactics) in a series of large scale laboratory and field experiments, integrating several previously independent perspectives from evolutionary ecology, ecophysiology and genomics, to produce a downstream predictive model. The chosen study species, the brown trout S*almo trutta*, has an extensive history of genetic and experimental work and exhibits 'partial migration': individuals either migrate to sea ('sea trout') or remain in freshwater their whole lives. Recent advances in molecular parentage assignment, quantitative genetics and genomics (next generation sequencing and bioinformatics) will allow unprecedented insight into how alternative life history phenotypes are moulded by the interaction between genes and environment. To provide additional mechanistic understanding of these processes, the balance between metabolic requirements during growth and available extrinsic resources will be investigated as the major physiological driver of migratory behaviour. Together these results will be used to develop a predictive model to explore the consequences of rapid environmental change, accounting for the effects of genetics and environment on phenotype and on population demographics. In addition to their value for conservation and management of an iconic and key species in European freshwaters and coastal seas, these results will generate novel insight into the evolution of migratory behaviour generally, providing a text book example of how alternative life histories are shaped and maintained in wild populations.

10.11 SFI-DEL Investigators Programme

SFI-DEL Investigators Programme 2015 15/IA/3028 (2016-2021)

Wild farmed interactions in a changing world: formulation of a predictive methodology to inform environmental best practice to secure long-term sustainability of global wild and farm fish populations.

This is a multidisciplinary study partnering the Marine Institute with University College Cork (joint project lead), Queen's University Belfast (joint project lead) and University of Glasgow funded by Science Foundation Ireland and the Department of Education and Learning for Northern Ireland which has commenced in 2016 to exploit novel analytical advances in population genomics (e.g. NGS; high density SNP arrays; gene expression; epigenetics) and quantitative genetics (e.g. animal model) to understand the complex effects of wild-farm hybridisation on the dynamics of quantitative traits and fitness in wild populations. The study aims to produce a working eco-genetic model for predicting the adaptive capacity of hybridised populations to respond to environmental change. The model can be directly applied to inform the sustainable management and/or restoration of wild populations in addition to the improvement of aquaculture strains. In addition we propose to test here several novel ideas: e.g. (1) the use of archives and pedigrees in common-garden and longitudinal studies to examine gene x environment interactions; (2) SNPs as biomarkers, which are linked to metabolism; (3) the first occurrence of the establishment of a Norwegian farm escape population in the wild outside Norway, which will enable the study of divergent selection in the farm fish in the wild relative to their farm progenitors; (4) surveys of gut and skin microbiomes and the application of assays for comprehensive screening of micro-parasites in Atlantic salmon.

10.12 BBSRC-SFI Responsive Mode

BBSRC-SFI Responsive Mode proposal Jes-1674874 (2016-2020)
A microbial basis for Atlantic salmon energetics

This multidisciplinary project which commenced in 2016 brings together world class UK and Irish fish biologists, population geneticists, microbiologists, bio-informaticians, engineers and major industry partners (Marine Institute, University College Cork – joint project lead, Marine Harvest and the University of Glasgow – joint project lead) to determine for the first time the role of salmon gut microbiota in defining host energetics, so paving the way for more sustainable salmon farming. Atlantic salmon (*Salmo salar*) are anadromous salmonids of major commercial, cultural and recreational importance in the UK, Ireland and worldwide. Metabolism, feed conversion efficiency and growth lie at the core of salmonid aquaculture productivity and its ecological impact and sustainability. The role of gut microbiota in driving energy metabolism in vertebrates is increasingly clear, opening up new avenues to fine-tune salmon metabolism and growth.

11 Publications

11.1 Peer-review

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